PHILOSOPHICAL TRANSACTIONS.

PART I.

A

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PHILOSOPHICAL TRANSACTIONS,

OF THE

ROYAL SOCIETY

OF

LONDON.

VOL. LXXI. For the Year 1781.

PART I.

LONDON,

SOLD BY LOCKYER DAVIS, AND PETER ELMSLY,
PRINTERS TO THE ROYAL SOCIETY.

MDCCLXXXI.

PHILOSOPHICAL TRANSACTIONS

OF THE

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OF

LONDON.

FOR THE YEAR 1781.

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MDCCLXXXI.

ADVERTISEMENT.

THE Committee appointed by the *Royal Society* to direct the publication of the *Philosophical Transactions*, take this opportunity to acquaint the Public, that it fully appears, as well from the council-books and journals of the Society, as from repeated declarations, which have been made in several former *Transactions*, that the printing of them was always, from time to time, the single act of the respective Secretaries, till the Forty-seventh Volume: the Society, as a body, never interesting themselves any further in their publication, than by occasionally recommending the revival of them to some of their Secretaries, when, from the particular circumstances of their affairs, the *Transactions* had happened for any length of time to be intermitted. And this seems principally to have been done with a view to satisfy the Public, that their usual meetings were then continued for the improvement of knowledge, and benefit of mankind, the great ends of their first institution by the Royal Charters, and which they have ever since steadily pursued.

But the Society being of late years greatly inlarged, and their communications more numerous, it was thought adviseable, that a Committee of their members should be appointed to reconsider the papers read before them, and select out of them such, as they should judge most proper for publication in the future *Transactions*; which was accordingly done upon the 26th of March 1752. And the grounds of their choice are, and will continue to be, the importance and singularity of the subjects, or the advantageous manner of treating them; without pretending to answer for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgment of their respective authors.

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It is likewiſe neceſſary on this occaſion to remark, that it is an eſtabliſhed rule of the Society, to which they will always adhere, never to give their opinion, as a body, upon any ſubject, either of Nature or Art, that comes before them. And therefore the thanks, which are frequently propoſed from the chair, to be given to the authors of ſuch papers, as are read at their accuſtomed meetings, or to the perſons through whoſe hands they receive them, are to be conſidered in no other light than as a matter of civility, in return for the reſpect ſhewn to the Society by thoſe communications. The like alſo is to be ſaid with regard to the ſeveral projects, inventions, and curioſities of various kinds, which are often exhibited to the Society; the authors whereof, or thoſe who exhibit them, frequently take the liberty to report, and even to certify in the public news-papers, that they have met with the higheſt applauſe and approbation. And therefore it is hoped, that no regard will hereafter be paid to ſuch reports, and public notices; which in ſome inſtances have been too lightly credited, to the diſhonour of the Society.

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A

SPEECH

DELIVERED TO

THE ROYAL SOCIETY,

ON WEDNESDAY NOVEMBER 30, 1780,

BEING THEIR ANNIVERSARY.

BY JOSEPH BANKS, ESQ.
PRESIDENT.

PRINTED BY ORDER OF THE COUNCIL.

THE Emotions of Gratitude inſpired by the very Place in which, by the Munificence of our Royal Patron, we are now for the firſt Time aſſembled, render it impoſſible for me to neglect the Opportunity which this Seaſon, when ye have been uſed to hear yourſelves addreſſed from the Chair, affords me, of offering my ſmall Tribute of Acknowledgement for a Benefit ſo eminently calculated to promote the Honour and Advancement of this Society.

Eſtabliſhed originally by the Munificence of a Royal Founder; foſtered and encouraged ſince that Time by every ſucceſſive Monarch who has ſwayed the Britiſh Sceptre, ye have ever proved yourſelves

worthy the Favor of your Royal Protectors. A NEWTON, who pruned his infant Wing under your Auſpices, when his maturer Flights ſoared to Worlds unmeaſurably diſtant, ſtill thought a Place among you an honorable Diſtinction. A NEWTON's immortal Labors, a BOYLE, a FLAMSTEAD, a HALLEY, a RAY, and many others, of whom I truſt it is needleſs to remind you, have made ample Returns for the Patronage of former Monarchs.

But bountiful as the Encouragement ye have received from former Patrons has ever been, the Favors which Science has, through your Interceſſion, received from his preſent Majeſty (whom GOD long preſerve!) have eminently outdone their moſt extenſive Ideas of Liberality. Ample Funds, by Him provided, have enabled you to reward Men of extenſive Knowledge and Ability, for ſpending whole Years in the Service of Science; obſerving twice the Tranſit of the Planet Venus over the Diſk of the Sun. At your Requeſt, the Publick defrayed the Expence of conveying

ing them to the moſt diſtant Parts of the Globe we inhabit, where the purpoſes of their Miſſion, ſo important to the Science of Aſtronomy, could beſt be fulfilled; while ye alone enjoy among your Fellow Academies the Reputation of having both ſent and rewarded them.

And more; thoſe very Donations were ſo liberally planned by that Attention to Science which has ever diſtinguiſhed His preſent Majeſty's Reign, and will for ever bear Teſtimony of his enlarged Mind, and Diſpoſition favorable to the Advancement of true Knowledge, that the Surplus alone enabled you, with his Royal Approbation, to inſtitute Experiments on the Attraction of Mountains, amidſt the barren and bleak Precipices of the Highlands of Scotland, which then, for the firſt Time, beheld Inſtruments of the niceſt Conſtruction tranſported to the Summits of their pathleſs Crags, and Men, uſed to other Habitations, voluntarily reſiding in temporary Huts, eager to expreſs a grateful Senſe of their Royal Patron's Libe-

rality,

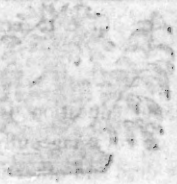
rality, by thus promoting to the utmoſt the Cauſe of Science, in which they were, under his Protection, embarked.

Gifts like theſe, unſolicited and unconditionally beſtowed, might have ſatisfied the Impulſes even of a Princely Munificence; but not ſo with our Royal Patron. Amply informed in every Branch of real Knowledge, He reſolved to beſtow a ſtill more diſtinguiſhed Mark of his Favor on Science which he loved, and in this his laſt beſt Gift has fulfilled his Royal Reſolution.

Such a Donation, ſo ſuited to our preſent proſperous and flouriſhing Condition under his Royal Patronage and Protection, is admirably calculated to increaſe the Reſpect, great as it is, which ye have ever received from the Learned of all Europe, placing you at once, in every Point of ſplendid Accommodation, as much above all Foreign Academies, as the Labors of your learned Predeceſſors had raiſed you above them in literary Reputation.

Let

Let then Gratitude to a Sovereign, from whom ye have received ſuch conſpicuous Encouragement, engage you, by an Application to a Promotion of the Sciences ye ſeverally poſſeſs, to deſerve a Continuance of his Royal Favor; to meaſure your future Exertions by the Standard of his princely Liberality; and thus ſhew the World, that ye ſtill are, as ye always have been, worthy the Patronage of your King!



ELOCUTION AND POLITE LITERATURE.

MR. HENRY SMEATHMAN, who was many years a pupil of the late Mr. Rice, and before he went on his travels, practiſed with ſucceſs that Author's ingenious method of teaching to read, ſpeak and write, with eaſe, energy and propriety; begs leave to offer his ſervices to the public in the ſame mode of uſeful and polite inſtruction.

Gentlemen intending themſelves for the Church, the Bar or the Senate, will by oral and familiar converſation, in a few months, receive more improvement, than by a ſolitary ſtudy of many years, in an art not taught in our Schools or Univerſities, yet abſolutely neceſſary to thoſe who wiſh to excel in public or polite life, or aſpire to eminence in eloquence and literature.

By this art, a liberal education is improved and accompliſhed, claſſical learning advantageouſly diſplayed, and the want of a proficiency in the dead and other languages ſupplied, as by Mr. Smeathman's method, founded on that of Mr. RICE, the pupils may acquire a critical knowledge of the idiom and elegance of their own without them.

This recommends it peculiarly to the attention of all thoſe who wiſh to have the pleaſure of reading the Engliſh claſſic authors with grace and propriety, or to write and ſpeak correctly; of thoſe Gentlemen, who are intended for the Navy, the Army, the Public-office or the Counting-houſe; or whoſe juvenile ſtudies may have been obliterated by an early introduction into thoſe ſituations; and of all thoſe who may have been deprived of the advantages of a liberal education.

They are effectually cured of any defects in pronunciation, which do not ariſe from an imperfection in the organs of ſpeech; and inſtead of provincial, diſagreeable or abſurd habits, they acquire an energetic, a perſuaſive and a graceful manner of ſpeaking, reading and reciting. Above all, the younger pupils receive this ſingular and important advantage, that their minds are opened more early, their reaſon is aſſiſted in its exertions, and directed to ſuch objects as naturally promote the perfection, and the happineſs of human beings.

This method is equally well adapted to both ſexes, thoſe advanced in life may receive inſtruction privately, as uſual, and Ladies will be attended at their own houſes.

Application may be made to Mr. Smeathman, at his Chambers, No 14. Clement's-Inn. Of whom, in a few days, may be had a ſhort Treatiſe on the nature of eloquence, and the importance of learning to read, ſpeak and write our own language, independent of all others; with a plan of his mode of teaching, and the advantages to be derived from it.

The following are detached extracts from the above-mentioned Treatiſe.

" Thoſe

"Thoſe who have not ſtudied and been exerciſed in reading,
"ſpeaking or compoſing, in their own language, will not do
"either in ſuch a manner as to claim or deſerve attention;
"and it is the talent of performing them with eaſe, energy
"and propriety, which we call eloquence.

"People are uſually very ſolicitous to have their children in-
"ſtructed in all thoſe liberal arts, which are deemed requiſite to
"perfect them as Gentlemen and Scholars: and ſurely as no-
"thing contributes more to this intention, they would not omit
"oratory, if they thought it was to be learned. They liſten
"with rapture to the charms of eloquence, but are not aware
"that it is in their power to procure this ineſtimable talent
"for thoſe who are the objects of their inceſſant care and daily
"anxiety."

"This can only ariſe from the erroneous idea that oratory is
"not to be taught or acquired. Yet no art is more ſimple in
"its Principles, or clearer in its rules, and no rules are more
"eaſily reduced to practice, or more certainly practiſed with
"ſucceſs."

"It is granted that people may improve themſelves much
"by private declamation. The art of eloquence, however,
"is in this reſpect like fencing, in which a man can learn
"very little by puſhing againſt a wall: he may indeed
"ſtrengthen his muſcles, and enable himſelf to bear the
"fatigue, but it is by frequent exertion with a maſter only
"that he can expect to acquire ſkill.

" It is from the friendly obſervations, the oral information,
" the frequent contentions and the unreſtrained corrections,
" of a ſkilful companion, that a ſtudent in oratory can derive
" eſſential improvement: writing alone can no more commu-
" nicate the art than it can ſpeech to the dumb.

" Thoſe therefore who educate their children for eminent
" ſtations in life, with the hope that they will one day render
" themſelves conſpicuous in the Senate, the Church or the
" courts of Law and Juſtice, without having them grounded in
" the firſt principles of eloquence, expect to reap where they
" have not ſown: they muſt in all probability be diſappoint-
" ed."———

—" There is ſcarce a man of a moderate age and capacity not
" born with ſome invincible imperfection in the organs of
" ſpeech, who may not in twelve months be enabled to com-
" municate his thoughts with pleaſure to his audience, and
" credit to himſelf; or ſo to read the Liturgy as to excite
" Devotion in the moſt lukewarm, and to confirm it by a na-
" tural, perſuaſive and convincing manner of delivering the
" great and eſſential truths of Religion; and how much this
" is to be wiſhed is left to the opinion of all who have heard
" the diſguſting and unedifying manner in which the fineſt
" compoſitions are generally delivered in our public places of
" worſhip, and ſeen the awkward figures ſome of our learned
" Senators make when they attempt to ſpeak in Parliament."—

—" We have hitherto treated only of the moſt obvious advan-
" tages ariſing from the ſtudy of eloquence. On a cloſer
" view,

" view, many other important benefits will be found to be
" derived from it. Of theſe, opening the mind, improving
" the heart and infuſing a deſire of knowledge, deſerve par-
" ticular notice. Such is the tendency, effect and benefit, of
" the mode of inſtruction here recommended; for as it applies
" directly to the underſtanding without burthening the me-
" mory, or perplexing the mind, the youngeſt pupils recur
" to it with delight; and its uncommon ſucceſs, when at-
" tempted, has ariſen from the immediate conviction which
" they feel, that our path to knowledge is pleaſant, and
" the poſſeſſion of it highly advantageous and deſirable."—

" Our youth are generally very defective in thoſe polite
" Branches of Knowledge without which claſſical Learning is
" of little uſe. Their manners frequently continue rough and
" puerile, when they ought to be graceful and manly, their
" ſpeech inarticulate or ſlovenly, diſſonant or defective, diſ-
" agreeable, and often unintelligible; and very few, even
" among thoſe who are good ſcholars, can read or write their
" own language with eaſe or propriety: an accompliſhment
" abſolutely neceſſary to thoſe who wiſh to derive any advan-
" tage from extenſive knowledge or profound erudition."

" Young People are naturally emulous of the company of
" perſons reſpectable either for their Rank or Abilities, and if
" they paſs their time with low or ignorant people it is for
" want of being properly introduced and accuſtomed to mix in
" the converſation of men of poliſhed manners and liberal ac-
" compliſhments."———

—" The mode of Inſtruction here recommended, muſt neceſ-
" ſarily in its Courſe remove theſe Defects, and the prejudices

" intailed

" intailed on them; and promote the acquiſition of thoſe " uſefull arts, on which the Succeſs of life ſo much depends."

" In the proſecution of it their Curioſity is excited and di- " rected to proper objects, and a deſire for general knowledge " the great foundation of excellence, implanted by making them " acquainted with ſuch remarkable things in nature and art " as are worthy of Attention. Inſtead of a ſlovenly or ungrace- " full mode of ſpeaking, they are taught to deliver their ſenti- " ments with propriety and preciſion according to times and " circumſtances; conſequently their manner when improper " is reformed inſenſibly, and without appearing an object of " attention; their Minds are cultivated by frequent appeals " to their underſtanding, and their judgements regulated by " the conſtant habit of obſervation and reflection, exerciſed " in a Minute enquiry into the Truth and propriety of ſuch " thoughts as they are directed to in the courſe of their ſtudy. " Thus being early qualified for the company of well bred and " intelligent people they appear with becoming confidence and " ſatisfaction on all occaſions."———

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PHILOSOPHICAL TRANSACTIONS.

I. *Natural History and Description of the* Tyger-cat *of the* Cape of Good Hope. *By* John Reinhold Forster, *LL.D. F. R. and A. S.*

Read November 9. 1780.

FEW tribes of quadrupeds have in Africa more representatives of their different species than that of the CAT. The genus of *Antelopes* may perhaps be excepted, since, to my knowledge, about twenty different *Ghazels* and *Antelopes* are to be met with in Africa; but no more than about eight or nine of the Cat tribe have hitherto been discovered on that continent. However, I know about twenty-one different species of this

great claſs; and, I ſuppoſe, theſe by no means exhauſt this numerous tribe.

The greater and more numerous the different genera of animals are, the more difficult it muſt be to the natural hiſtorian properly to arrange the whole of ſuch an extenſive diviſion of animals, eſpecially if they are not equally well known. To form new genera, in order to diſpoſe and arrange them under, is a remedy which increaſes the evil, inſtead of curing it. The beſt method, therefore, which can be deviſed, is to make great diviſions in each genus, comprehending thoſe ſpecies which, on account of ſome common relation or character, have a greater affinity to one another. The genus of Cat, to which the animal belongs we are going to ſpeak of more at large, offers three very eaſy and natural ſub-diviſions. The *firſt* comprehends animals related to the Cat-tribe, with long hair or manes on their necks; *ſecondly*, ſuch as have remarkable long tails without any marks of a mane on their necks; *laſtly*, ſuch as have a bruſh of hair on the tips of their ears, and ſhorter tails than the ſecond ſub-diviſion. The firſt might be called in Latin *Feles jubatæ*; the ſecond ſub-diviſion ſhould be named *Ælures*; and the third and laſt, *Lynces*. To the firſt ſub-diviſion the *Lion* and the *hunting Leopard* or Indian *Chittah*, belong. The ſecond ſub-diviſion conſiſts of the *Tyger*, the *Panther*, the *Leopard*, the *Ounce*, the *Puma*, the *Jaguar-ete*, the *Jaguara*, the *Ocelot*, the *Gingy* of Congo, the *Marakaya*, the Tyger-cat of the Cape or the *'Nſuſſi* of *Congo*, the *Tibetan Tyger-cat* which I ſaw at Peterſburg, the common *Buſh-cat of the Cape*; and, laſtly, the *wild Cat*, and its domeſtic varieties. To the third diviſion belong the *Lynx*, the *Caracal*, the *Serval*, the *Bay Lynx*, and the *Ghaus* of Profeſſor GULDENSTEDT.

Since

Since it is quite foreign to my purpoſe to ſpeak of thoſe ſpecies which are known already to the naturaliſt, I confine myſelf to that ſpecies only which hitherto has been imperfectly known to naturaliſts.

The firſt notice we had of the Cape Cat is, in my opinion, to be met with in LABAT's *Relation Hiſtorique de l'Ethiopie occidentale*, tom. I. p. 177. taken as is ſuppoſed from Father CARAZZI. LABAT mentions there the '*Nſuſſi*, a kind of wild Cat of the ſize of a Dog, with a coat as much ſtriped and varied as that of a *Tyger*. Its appearance beſpeaks cruelty, and its eyes fierceneſs; but it is cowardly, and gets its prey only by cunning and inſidious arts. All theſe characters are perfectly applicable to the Cape Cat, and it ſeems the animal is found in all parts of Africa, from Congo to the Cape of Good Hope, in an extent of country of about eleven degrees of latitude. KOLBE, in his *Preſent State of the Cape Good Hope*, vol. II. p. 127. (of the Engliſh edition) ſpeaks of a *Tyger Buſh-cat*, which he deſcribes as the largeſt of all the wild Cats of the Cape-countries, and is ſpotted ſomething like a Tyger. A ſkin of this animal was ſeen by Mr. PENNANT in a furrier's ſhop in London, who thought it came from the Cape of Good Hope; from this ſkin Mr. PENNANT gave the firſt deſcription which could be of any utility to a natural hiſtorian*. All the other authors mention this animal in a vague manner. When I and my ſon touched the ſecond time at the Cape of Good Hope in the year 1775, an animal of this ſpecies was offered me to purchaſe; but I refuſed buying it becauſe it had a broken leg, which made me apprehenſive of loſing it by death during the paſſage from the Cape to London. It was very gentle and tame. It was brought in a

* PENNANT's Synopſis of Quadrupeds, p. 181. firſt edit.

baſket to my apartment, where I kept it above four and twenty hours, which gave me the opportunity of deſcribing it, and of obſerving its manners and œconomy; as it did to my ſon that of making a very accurate drawing of it.

After a moſt minute examination, I found its manners and œconomy perfectly analogous to thoſe of our domeſtic Cats. It ate freſh raw meat, and was very much attached to its feeders and benefactors: though it had broke the fore-leg by accident, it nevertheleſs was very eaſy. After it had been ſeveral times fed by me, it ſoon followed me like a tame favourite Cat. It liked to be ſtroked and careſſed; it rubbed its head and back always againſt the perſon's cloaths who fed it, and deſired to be made much of. It purred as our domeſtic Cats do when they are pleaſed. It had been taken when quite young in the woods, and was not above eight or nine months old; I can, however, poſitively aver, having ſeen many ſkins of full-grown Tyger-cats *, that it had already very nearly, if not quite, attained its full growth. I was told, that the Tyger-cats live in mountainous and woody tracts, and that in their wild ſtate they are very great deſtroyers of Hares, Rabbits, Yerbuas, young Antelopes, Lambkins, and of all the feathered tribe.

DESCRIPTIO FELIS CAPENSIS.

Felis cauda ſub-elongata, annulata; corpore fulvo, ſupra maculis virgatis infra orbicularibus, auriculis nigris, macula lunata alba.

* Theſe ſkins, with ſeveral others of rare and non-deſcript animals, I bought at a very conſiderable expence, and depoſited in the Britiſh Muſeum, that valuable national repoſitory of artificial and natural curioſities.

Nſuſſi. LABAT Ethiopic. occident. tom. I. p. 177.

Tyger Boſch-katten. KOLBE Cape of Good Hope, vol. II. p. 127. (Engl. edit.)

Cape-cat. PENNANT Syn. Quadrup. p. 181. (1ſt edit.)

Corpus magnitudine *Felis Cati ſylveſtris* vel paulo majus. In genere ſupra colore pallide fulvo, ſubtus e cinereo albo, maculis atris.

(*Pili* apice pallide fulvi, baſi albi.)

Caput Roſtro magis acuto, quam F. Cati, albo; in labio ſuperiore prope angulum rictus macula orbiculata, nigra. *Nares* nudæ, atræ. *Myſtaces* plurium ordinum in labio ſuperiore et ſupra oculos validæ, albæ et fulvæ. *Oculi* figura fere trianguli ſphærici, latere anteriore perpendiculari; *Irides* flavæ. *Pupilla* orbicularis, diurna (nec ut in F. Cato perpendiculari rima lemniſcata). *Lingua* retroſum aculeata. *Dentes* acuti ut in cogeneribus.

Linea albida utrinque naſo parallela, ad interiora oculorum latera. *Linea nigra* paullulum convergens a cantho anteriore oculorum deſcendit in naſum; *aliæ duæ nigræ* ſupra oculos infra convergentes, inque frontem aſcendentes; præterea in capite *puncta et lineolæ nigræ* plures ſparſæ.

Auriculæ amplæ, longitudine fere capitis, ovatæ, ſuberectæ, *intus* villoſæ, ochroleucæ; *extus* nigræ, macula lunata, tranſverſa alba. *Margo exterior* ſacculo membranaceo nudo, lobato.

Corpus ovatum, elegans. *Lineæ atræ* longitudinales quatuor in cervice inter aurium baſes orſæ, in *Dorſo* interruptæ; *Superiora laterum* obtinent maculæ oblongæ, lineares, obliquæ. *Inferiora laterum* maculis rotundis ſparſis. *Abdomen* e cinereo-album, maculis rotundis parvis, ſparſis, nigris.

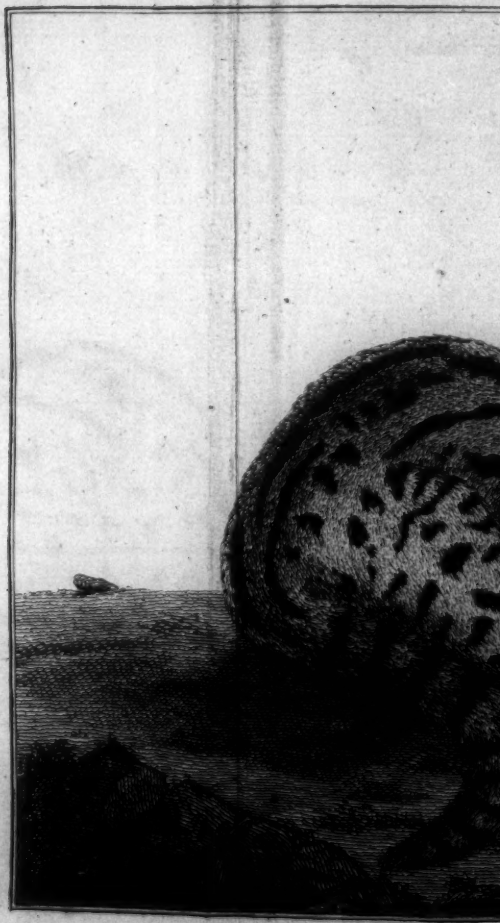
Pedes

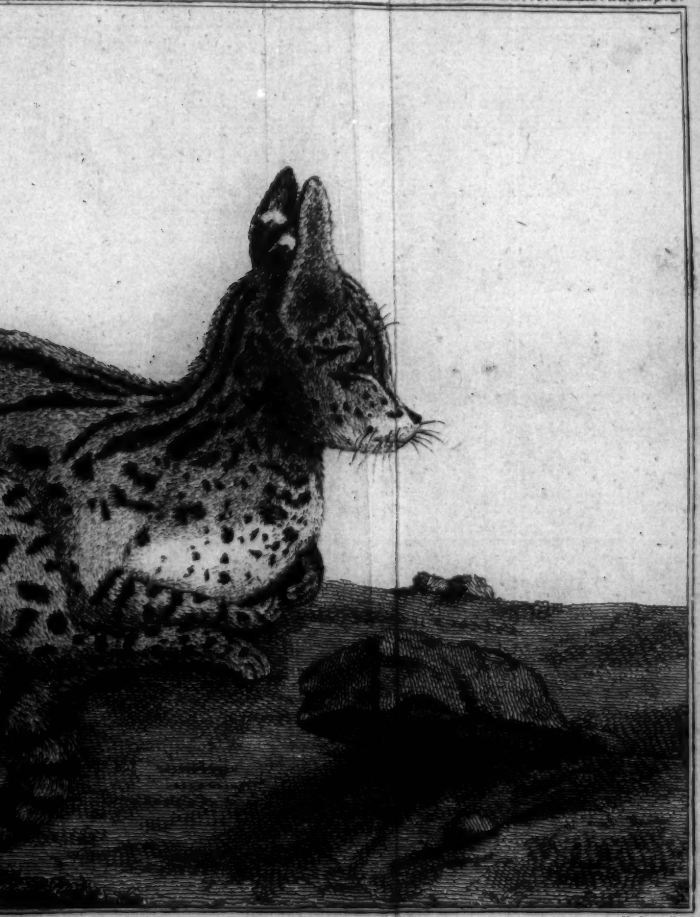
Pedes omnes ſuperne ſubfaſciati, extremitatibus punctis numeroſis, nigris conſperſi. *Digiti* quinque felini. *Ungues* modici, retractiles, nigri.

Cauda attingit baſin tarſi, annulis circiter octo vel decem nigris cincta.

MENSURÆ.

Ab apice roſtri ad baſin caudæ -	18 unciæ ped. Angl.
Cauda - - -	8
Caput longum - - - -	4
Auriculæ margine exteriore -	3
Pedes anteriores a cubito - -	7
Pedes poſtici (tarſi ſcilicet) -	4½





BASIRE SC.

II. *Experiments and Obſervations on the ſpecific Gravities and attractive Powers of various ſaline Subſtances.* By Richard Kirwan, *Eſq. F. R. S.*

Read November 16, 1780.

THE doctrine of chymical affinities hath of late received great improvements from the labours of the very excellent Mr. BERGMAN of Upſal, and the ſtill later reſearches of Mr. WENTZEL; but the order of theſe attractions has hitherto been the only point attended to by theſe philoſophers, as well as by moſt preceding chymiſts: for I know of none, except Mr. MORVEAU of Dijon, who has thought of aſcertaining the various degrees of force of chemical attraction, by which one body acts on various other bodies, or even on the ſame body in various circumſtances. He has, however, ſo ably ſhewn the advantages ariſing from ſuch an inquiry, that I have made it the object of my attention, and beſtowed much pains on it for ſome time paſt; and have been thereby enabled to determine pretty exactly the proportion of the ingredients of many neutral ſalts, and the ſpecific gravity of the mineral acids in their pureſt ſtate, and free from all water. The principles on which theſe determinations are founded are the following.

1ſt. That the ſpecific gravity of bodies is as their weight, divided by the weight of an equal bulk of rain or diſtilled water, this being at preſent the ſtandard with which every other body is compared.

2dly.

2dly. That if bodies, ſpecifically heavier than water, be weighed in air and in water, they loſe in water part of the weight which they were found to have in air; and that the weight ſo loſt is juſt the ſame as that of an equal bulk of water, and conſequently that their ſpecific gravity is equal to their weight in air, or *abſolute weight*, divided by their loſs of weight in water.

3dly. That if a ſolid, ſpecifically heavier than a liquid, be weighed firſt in air, and then in that liquid, the weight it loſes is equal to the weight of an equal volume of that liquid; and conſequently if ſuch ſolid be weighed firſt in air, then in water, and afterwards in any other liquid, the ſpecific gravity of this liquid will be as the weight loſt in it by ſuch ſolid, divided by the loſs of weight of the ſame ſolid in water. This method of finding the ſpecific gravity of liquids I have found much more exact than that by the areometer, or the compariſon of weights of equal meaſures of ſuch liquids and water, both of which are ſubject to ſeveral inaccuracies.

4thly. That where the ſpecific gravity of bodies is already known, the weight of an equal bulk of water may alſo be found, it being as the quotient of their abſolute weight divided by their ſpecific gravity. This I ſhall call their *loſs of weight* in water.

Hence, where the ſpecific gravity and abſolute weight of the ingredients of any compound are known, the ſpecific gravity of ſuch compound may eaſily be calculated as it ought to be intermediate betwixt that of the lighter and that of the heavier, according to their ſeveral proportions: this I call the *mathematical* ſpecific gravity. But, in fact, the ſpecific gravity of compounds, found by actual experiment, ſeldom agrees with that found by calculation, but is often greater without any diminu-

tion of the lighter ingredient. This increase of density must then arise from a closer union of the component parts to each other than either had separately with its own integrant parts; and this more intimate union must proceed from the attraction or affinity of these parts to each other: I therefore imagined this attraction might be estimated by the increase of density or specific gravity and was proportionable to it, but was soon undeceived.

I must also premise, that the absolute weights of many sorts of air have been accurately determined by Mr. FONTANA, at whose experiments I was present, the thermometer being at 55°, and the barometer at 29½ inches, or nearly so. Their weights were as follows:

	Gr.
Cubic inch of common air	0,385
Fixed air	0,550
Marine air	0,654
Nitrous air	0,399
Vitriolic air	0,778
Alkaline air	0,2
Inflammable air	0,035

OF SPIRIT OF SALT.

From the time I first read in Dr. PRIESTLEY's Experiments on Air (that inexhaustible source of future discoveries) of the exhibition of marine acid in the form of air, free from water; and that this air, reunited with water, formed an acid liquor in all respects the same as common spirit of salt; I conceived the possibility of discovering the exact quantity of acid in spirit of salt of any given specific gravity, and by means of

this the exact proportion of acid in all other acid liquors; for if a given quantity of pure fixed alkali were ſaturated, firſt by a certain quantity of ſpirit of ſalt, and then by determined quantities of the other acids, I concluded, that each of theſe quantities of acid liquor muſt contain the ſame quantity of acid, and this being known, the remainder being the aqueous part, this alſo muſt be known; but this concluſion intirely reſted on the ſuppoſition that the ſame quantity of all the acids was requiſite for the ſaturation of a given quantity of fixed alkali; for if ſuch given quantity of fixed alkali might be ſaturated by a ſmaller quantity of one acid than of another, the concluſion fell to the ground. This point might, indeed, be in ſome meaſure determined by weighing the neutral ſalts, formed by theſe acids, when thoroughly dry; but ſtill a ſource of inaccuracy remained: for if they were expoſed to a conſiderable heat, part of the acid would neceſſarily be expelled, and more of one acid than of another, and if the heat were not conſiderable, much of the water of cryſtallization would remain; ſo that if the weights were found to be equal, this equality could not be aſcribed to equal quantities of acid, but might perhaps ariſe from a ſmaller proportion of acid in one of them, and a larger proportion of water, and in another from a larger proportion of acid and a ſmaller proportion of water; and if the weights were unequal, no certain concluſion could be drawn. To obviate this difficulty I uſed the following expedient. 1ſt. I ſuppoſed the quantities of nitrous and vitriolic acids, neceſſary to ſaturate a given quantity of fixed alkali, exactly the ſame as that of marine acid whoſe quantity I determined; and to prove the truth of this ſuppoſition, I obſerved the ſpecific gravity of the ſpirit of nitre and oil of vitriol I made uſe of, and in which I ſuppoſed, from the trial with alkalies, a certain proportion of

acid and water; I then added to theſe more acid and water, and calculated what their ſpecific gravities ſhould be upon the above ſuppoſition, and finding the reſult to tally with the ſuppoſition, I concluded the latter to be exact.

The experiments made on the marine acid were as follows.

I took two bottles, which I filled nearly to the top with diſtilled water, of which they contained in all 1399,9 gr. and introduced them ſucceſſively into two cylinders filled with marine air, which I had obtained from common ſalt by means of dilute oil of vitriol and heat, in a mercurial apparatus; and this proceſs I renewed until the water had imbibed, in eighteen days, about 794 cubic inches of the marine air. The thermometer did not riſe all this time above 55°, nor ſink, unleſs perhaps at night, under 50°, and the barometer was between 29 and 30 inches. This water, or rather ſpirit of ſalt, I then found to weigh 1920 gr. that is 520,1 more than before. The quantity of marine air abſorbed amounted then to 520,1 gr. I then examined the ſpecific gravity of this ſpirit of ſalt, and found it to be 1,225. Its loſs of weight in water (that is, the weight of an equal bulk of water) ſhould then be 1567,346 gr. nearly; but it contained only, as we have ſeen, 1399,9 gr. of water: therefore ſubtracting this from 1567,346, the remainder (that is, 167,446) muſt be the loſs of 520,1 gr. of marine acid; and conſequently the ſpecific gravity of the pure marine acid, in ſuch a condenſed ſtate as it is in when united to water, muſt be $\frac{520,1}{167,446} = 3,100$. But ſtill it might be ſuſpected, that the denſity of this ſpirit did not intirely proceed from the mere denſity of the marine acid, but in part alſo from the attraction of this acid to water, and though the length of time requiſite to make water imbibe this quantity of acid made me judge that the

attraction was not very conſiderable, yet the following experiment was more ſatisfactory.

I expoſed 1440 gr. of this ſpirit to marine air for five days, the thermometer being at 50° or under; it then weighed 1562 gr. and conſequently imbibed 122 gr. of marine air; its ſpecific gravity was then 1,253, which agrees exactly with what it ſhould be by calculation.

N. B. I have not repeated the whole of theſe experiments, as they were very tedious; but I began them over again ſeveral times before I could aſcertain with any preciſion the quantity of marine air abſorbed, as, when the whole of a cylinder full of air was abſorbed, it was difficult to ſtop the bottles ſo as to prevent any mercury from falling in; and I was obliged every night to fill the cylinders with air, leſt if there remained but a ſmall quantity it might be imbibed before morning, and the mercury fall into the bottles. I alſo made ſome allowance for the common air which I could not avoid letting into the cylinder with the marine air, as will be very apparent to whoever repeats the experiment.

Being now ſatisfied I had diſcovered the proportion of acid and water in ſpirit of ſalt, I was impatient to find it in other acids alſo; and for that purpoſe I took 180 gr. of very ſtrong oil of tartar *per deliquium*, but of whoſe ſpecific gravity I can find no note, and found it to be ſaturated by 180 gr. of ſpirit of ſalt, whoſe ſpecific gravity was 1,225. Now, by calculation it appears, that 180 gr. of this ſpirit contains 48,7 gr. of acid and 131,3 of water, and hence I drew up the following table.

Marine

Marine acid.	Water.	Specific Gravity.
Parts.	Parts.	
	50	1,497
	60	1,431
	70	1,381
	80	1,341
	90	1,308
	100	1,282
	110	1,259
	120	1,246
	130	1,223
	140	1,209
	150	1,196
	160	1,185
	170	1,175
	180	1,166
	190	1,158
	200	1,151
	210	1,144
	220	1,138
48,7	230	1,132
	240	1,127
	250	1,122
	260	1,118
	270	1,114
	280	1,110
	290	1,106
	300	1,103
	310	1,100
	320	1,097
	330	1,091
	340	1,089
	350	1,086
	360	1,084
	370	1,082
	380	1,080
	390	1,078
	400	1,076
	410	1,074

The ſpecific gravity of the ſtrongeſt ſpirit of ſalt, made in the uſual way, is, according to Mr. BAUME, 1,187, and according to Mr. BERGMAN, 1,190; but we read in the Paris Memoirs for the year 1700, p. 191. that Mr. HOMBERG paſſed a ſpirit whoſe ſpecific gravity was 1,300; and that made by Dr. PRIESTLEY (ſee vol. III. p. 275.) muſt have been about 1,500.

Hence we ſee, that ſpirit of ſalt, whoſe ſpecific gravity is 1,261 or leſs, has little or no attraction with water, and therefore attracts none from air, and on that account does not heat a thermometer whoſe ball is dipped in it as ſpirit of vitriol and ſpirit of nitre do, as has lately been obſerved by the Friendly Society of Berlin.

This table is not exactly accurate, as I had not in this firſt experiment found the point of ſaturation as nicely as was requiſite. However, I have not corrected it, as the error is but ſmall, and the proportion may at any time be found by calculation; at leaſt when the ſpecific gravity of this ſpirit does not exceed 1,253. Whether the mathematical ſpecific gravity and that by obſervation differ in the higher degrees of ſpecific gravity, I have not examined; but the table is formed on the ſuppoſition that they do not.

Common

Common ſpirit of ſalt is always adulterated with vitriolic acid, and therefore not fit for theſe trials.

Intending to determine by this experiment the proportion of acid, water, and fixed alkali in digeſtive ſalt, as it is called, I took 100 gr. of a ſolution of a tolerably pure vegetable alkali that had been three times calcined to whiteneſs, the ſpecific gravity of which ſolution was 1,097. I alſo diluted the ſpirit of ſalt with different portions of water; the ſpecific gravity of one ſort was 1,115, and of another 1,098.

I then found that the above quantity of the ſolution of a vegetable alkali required for its ſaturation 27 gr. of that ſpirit of ſalt whoſe ſpecific gravity was 1,098, and 23,35 gr. of that ſpirit of ſalt whoſe ſpecific gravity was 1,115. Now, 27 gr. of ſpirit of ſalt, whoſe ſpecific gravity is 1,098, contain 3,155 gr. of marine acid, as appears by calculation. As the principle on which this calculation, by which the proportion of ſubſtances in alloy is found, may not be generally known, I ſhall here mention them in the words of Mr. COTES.

"The *data* requiſite are the ſpecific gravities of the mixture "and of the two ingredients. . . . . Then, as the difference "of the ſpecific gravities of the mixture and the lighter ingre- "dient is to the difference of the ſpecific gravities of the mix- "ture and the heavier ingredient, ſo is the magnitude of the "heavier to the magnitude of the lighter ingredient. Then, "as the magnitude of the heavier multiplied into its ſpecific "gravity is to the magnitude of the lighter multiplied into its "ſpecific gravity, ſo is the weight of the heavier to the weight "of the lighter . . . . Then, as the ſum of theſe weights "is to the given weight of either ingredient, ſo is the weight "given to the weight of the ingredient ſought."

Thus,

Thus, in this caſe, 1,098 − 1,000 = ,098 is the magnitude of the heavier ingredient, *viz.* the marine acid; and, 098 × 3,100 = 0,3038 the weight of the marine acid: and, on the other hand, 3,100 − 1,098 = 2,002 the magnitude of the water, and 2,002 × 1,000 = 2,002 its weight; the ſum of theſe weights is 2,3058: then, if 2,3058 parts of ſpirit of ſalt contain 0,3038 parts acid, 27 gr. of this ſpirit of ſalt will contain 3,55 acid.

In the ſame manner it will be found, that 23,35 gr. of ſpirit of ſalt, whoſe ſpecific gravity was 1,115, contained 3,55 gr. acid.

The point of ſaturation was pretty accurately found by putting the glaſs cylinder which contained the alkaline ſolution on the ſcale of a very ſenſible balance, and at the ſame time weighing the acid liquor in another pair of ſcales, when the loſs of weight indicated the eſcape of nearly equal quantities of the fixed air contained in the ſolution; then the acid was gradually added, by dipping a glaſs rod into it, to the top of which a ſmall drop of acid adhered: with this the ſolution was ſtirred, and very ſmall drops taken up and laid on bits of paper ſtained blue with radiſh juice. As ſoon as the paper was in the leaſt reddened, the operation was completed ſo that there was always a very ſmall exceſs of acid, for which half a grain was conſtantly allowed; but no allowance was made for the fixed air, which always remains in the ſolution; but as, on this account, only a ſmall quantity of the alkaline ſolution was uſed, this proportion of fixed air muſt have been inconſiderable. If an ounce of the ſolution had been employed, this inappreciable portion of fixed air would be ſufficient to cauſe a ſenſible error: for I judged of the quantity of fixed air loſt by the difference betwixt the weight added to the 100 gr. and the actual weight

of

of the compound. When this difference amounted to 2,2 gr. then I judged the whole of the fixed air expelled, and found it to be ſo, as 100 gr. of this alkaline ſolution, being evaporated to dryneſs in a heat of 300°, left a reſiduum which amounted to 10¼ gr.; which 10¼ gr. contained 2,2 gr. of fixed air, as will hereafter be ſeen.

Hence 8,3 gr. of pure vegetable fixed alkali, free from fixed air and water, or 10,5 of mild fixed alkali, were ſaturated by 3,55 gr. of pure marine acid, and conſequently the reſulting neutral ſalt ſhould, if it contained no water, weigh 11,85 gr.; but the ſalts reſulting from this union (the ſolution being evaporated to perfect dryneſs in a heat of 160° kept up for four hours) weighed at a medium 12,66 gr. Of this weight 11,85 gr. were acid and alkali; therefore the remainder, *viz.* 0,81 of gr. were water; therefore 100 gr. of perfectly dry, digeſtive ſalt contain 28 gr. acid, 6,55 water, 65,4 of fixed alkali.

I was then curious to compare my experiments with thoſe made by others, but could not find any made with ſufficient preciſion but thoſe of Mr. HOMBERG in the Paris Memoirs for 1699. However, as to ſpirit of ſalt I did not think proper to compare them, as he mentions that his could diſſolve gold, and therefore was probably impure.

OF SPIRIT OF NITRE.

The common reddiſh brown or greeniſh ſpirit of nitre containing, beſides acid and water, a certain portion of phlogiſton, and being alſo mixed with ſome portion of the acid of ſea ſalt, I judged unfit for theſe trials, and therefore uſed only the dephlogiſticated ſort, which is quite colourleſs, and reſembles pure water in its appearance. This pure acid cannot be made to exiſt

in

in the form of air, as Dr. PRIESTLEY has shewn; for when it is deprived of water and phlogiston, and furnished with a due proportion of elementary fire, it ceases to have the properties of an acid, and becomes dephlogisticated air; I could not, therefore, determine its proportion in spirit of nitre as I had done that of the marine acid, but was obliged to use another method.

1st. To 1963,25 gr. of this spirit of nitre, whose specific gravity was 1,419, I gradually added 179,5 gr. of distilled water, and when it cooled I found the specific gravity of this mixture 1,389.

2dly. To 1984,5 gr. of this I again added 178,75 gr. of water; its specific gravity was then 1,362.

I then took 100 gr. of a solution of fixed vegetable alkali, whose specific gravity was 1,097, the same I had before used in the trials with spirit of salt, and found this quantity of alkali to be saturated by 11 gr. of the spirit of nitre, whose specific gravity was 1,419; and by 12 gr. of the spirit, whose specific gravity was 1,389; and by 13,08 of that, whose specific gravity was 1,362. The quantities here mentioned were the medium of five experiments. I found it necessary to dilute the nitrous acid with a small proportion of water, of which I kept an account. When I neglected this precaution, I found that part of the acid was phlogisticated, and went off with the fixed air. Note also, that after each affusion of acid ten minutes were allowed to the matters to unite, a precaution which I also found absolutely necessary.

Hence (upon the supposition that a given quantity of fixed vegetable alkali is saturated by the same weight of both acids) we see that 11 gr. of spirit of nitre, whose specific gravity is 1,419, contain the same quantity of acid as 27 gr. of spirit of

ſalt, whoſe ſpecific gravity is 1,098, that is, 3,55 gr.; the remainder of 11 gr. is therefore mere water, *viz.* 7,45 gr.; conſequently, if the denſity of the acid and water had not been increaſed by their union, the ſpecific gravity of the pure and mere nitrous acid ſhould be 11,8729; for the ſpecific gravity of this acid ſhould be as its abſolute weight divided by its loſs of weight in water, and this loſs ſhould be as the total loſs of theſe 11 gr. minus the loſs of the aqueous part. Now the total loſs $= \frac{11}{1,419} = 7,749$, and the loſs of the aqueous part $= 7,45$, and conſequently the loſs of the acid part is $7,749 - 7,45 = 0,299$, and therefore the ſpecific gravity of the acid part, that is, of the pure nitrous acid, is $\frac{3,55}{0,296} = 11,8729$.

But it is well known, that the denſity of the nitrous acid, as well as that of the vitriolic, is increaſed by its union with water; and therefore the loſs above found is not the *whole* of its real loſs in its natural ſtate (if it could be ſo found), but partly the loſs that ariſes from the denſity that accrues to it from its union with water: for ſince its denſity is increaſed by this union, its loſs is leſs than it would be if the nitrous acid had only its own proper denſity, and conſequently the ſpecific gravity above found is greater than its real ſpecific gravity.

To determine, therefore, the real ſpecific gravity of this acid in its natural ſtate, the quantity of *accrued* denſity muſt be found, and ſubtracted from the ſpecific gravity of the ſpirit of nitre, whoſe true mathematical ſpecific gravity will then appear. I endeavoured to effect this by mixing different portions of ſpirit of nitre and water, remarking the diminution of their joint volume below the ſum of the ſpaces occupied by their ſeparate volumes; but could never attain a ſufficient degree of

preciſion. The following method, though not exactly accurate I found more ſatisfactory. 12 gr. of the ſpirit of nitre, whoſe ſpecific gravity by obſervation was 1,389, contained as I ſuppoſed from the former experiment 3,55 gr. of acid, and 8,45 of water; then if the ſpecific gravity of the pure nitrous acid were 11,872, the ſpecific gravity of this compound of acid and water ſhould be 1,371; for the loſs of 3,55 gr. acid ſhould be 0,299, and the loſs of the water 8,45; the ſum of the loſſes 8,749. $\frac{12}{8,749} = 1,371$; but, as I already ſaid, the ſpecific gravity by obſervation was 1,389, therefore the *accrued* denſity in this caſe was at leaſt ,018, the difference betwixt 1,389 and 1,371. I ſay *at leaſt*, for as the ſpecific gravity 11,872 was certainly too high, the loſs of 3,55 gr. acid was certainly too ſmall; and if it were greater, the mathematical ſpecific gravity 1,371 would have been ſtill lower. However, ,018 is certainly a near approximation to the degree of denſity that accrues to 3,55 gr. acid by their union to 7,45 gr. of water, and differs inconſiderably from the truth, as will appear by the ſequel: therefore ſubtracting this quantity from 1,419 we have nearly the mathematical ſpecific gravity of that proportion of acid and water, namely, 1,401. And ſince 11 gr. of this ſpirit of nitre contain 3,55 gr. acid and 7,45 of water, its loſs of weight ſhould be $\frac{11}{1,401} = 7,855$, and ſubtracting the loſs of the aqueous part from this, the remainder 0,405 is the loſs of the 3,55 gr. acid, and conſequently the true ſpecific gravity of the pure and mere nitrous acid is $\frac{3,55}{0,405} = 8,7654$: this being ſettled, the mathematical ſpecific gravity and true increaſe of denſity of the above mixtures will be found. Thus the mathematical ſpecific gravity of 12 gr. of that ſpirit of nitre, whoſe ſpecific gravity by

obſervation was 1,389, muſt be 1,355, ſuppoſing it to contain 3,55 gr. acid and 8,45 of water; for the loſs of 3,55 gr. acid is $\frac{3,55}{8,763} = 0,405$, and the loſs of water 8,45; the ſum of theſe loſſes is 8,855. Then, $\frac{12}{8,855} = 1,355$, and conſequently the accrued denſity is $1,389 - 1,355 = ,034$. In the ſame manner it will be found, that the mathematical ſpecific gravity of 13,08 gr. of that ſpirit of nitre, whoſe ſpecific gravity by obſervation was 1,362, muſt be 1,315, and conſequently its accrued denſity ,047.

But the whole ſtill reſts upon the ſuppoſition that each of theſe portions of ſpirit of nitre contain 3,55 gr. of acid. To verify this ſuppoſition, I could think of no better method than that of examining the mathematical ſpecific gravities of the firſt mixture I had made of ſpirit of nitre and water in large quantities; for if the mathematical ſpecific gravities of theſe agreed exactly with thoſe of the quantities I had ſuppoſed in ſmaller portions of each, I could not but conclude, that the ſuppoſitions of ſuch proportions of acid and water, as I had determined in each, was juſt; and that this was the caſe will appear by the following calculations.

1ſt. When to 1963,25 gr. of ſpirit of nitre, whoſe ſpecific gravity was 1,419, 179,5 gr. of water were added, the quantity of acid upon the above ſuppoſition ſhould be 634,53 gr.; for :: 11 . 3,55 :: 1963,25 . 634,53 . the quantity of water in thoſe 1963,25 gr. of ſpirit of nitre ſhould then be 1328,72, and after adding 179,5 gr. of water, the whole quantity of acid and water ſhould be 2142,75, the loſs of acid was $\frac{634,53}{8,7654} =$ 71,24, and the ſum of the loſſes 1580,46: then the mathematical ſpecific

ſpecific gravity ſhould be $\frac{2142,75}{1580,46} = 1,355$, which is exactly the ſame as that which was found in 12 gr. of this ſpirit of nitre, on the ſuppoſition that they contained 3,55 gr. acid.

Again: when to 1984,5 gr. of this mixture I added 178,75 gr. of water, the whole quantity of diluted ſpirit of nitre was 2163,25 gr. and the quantity of acid in 1984,5 gr. was 587,081 gr. for :: 12 : 3,55 :: 1984,5 . 587,081; the loſs of this quantity of acid is 66,96 gr. and the ſum of the loſſes of acid and water is 1643,129 gr.; and conſequently the mathematical ſpecific gravity ſhould be $\frac{2163,75}{1643,125} = 1,315$, which is the ſame as that determined in 13,08 gr. of the ſame mixture.

By continuing theſe mixtures until I found the mathematical ſpecific gravity and that by obſervation nearly to coincide, I was enabled to draw up the following table, in which if any errors be found, I hope they will be excuſed, from the impoſſibility of avoiding them where the weights muſt be found with ſuch extreme preciſion: the two firſt ſeries were only found by analogy.

Spirit of nitre.	Acid.	Water.	Accrued denſity.	Mathematical ſpecific gravity.	Specific gravity by obſervation	Attract. of the acid to water.	Attract. of water to the acid.
Grs.	Grs.	Grs.					
9	– –	5,45	,000	1,537	1,537	– –	– –
10	– –	6,45	,009	1,458	1,467	,009	,054
11	– –	7,45	,018	1,401	1,419	,018	,045
12	– –	8,45	,034	1,355	1,389	,027	,036
13,08	– –	9,53	,047	1,315	1,362	,036	,027
14,15	– –	10,6	,051	1,286	1,337	,045	,018
15,23	– –	11,68	,054	1,260	1,314	,054	,009
16,305	– –	12,755	,054	1,238	1,292	,054	,009
17,38	– –	13,83	,051	1,220	1,271		
18,445	– –	14,9	,047	1,205	1,252		
19,53	– –	15,98	,044	1,191	1,235		
20,605	– –	17,055	,042	1,180	1,222		
21,68	– –	18,13	,040	1,177	1,217		
22,755	– –	19,205	,038	1,160	1,198		
23,83	– –	20,28	,036	1,152	1,188		
24,905	– –	21,45	,033	1,144	1,177		
26,17	– –	22,62	,030	1,132	1,162		
27,34	3,55	23,79	,027	1,130	1,157		
28,51	– –	24,96	,026	1,124	1,150		
29,68	– –	26,13	,024	1,114	1,138		
30,85	– –	27,30	,022	1,113	1,135		
32,02	– –	28,47	,020	1,109	1,129		
33,09	– –	29,54	,018	1,102	1,120		
34,26	– –	30,71	,016	1,101	1,117		
35,43	– –	31,88	,014	1,097	1,111		
36,60	– –	33,05	,012	1,094	1,106		
37,77	– –	34,22	,010	1,090	1,100		
38,94	– –	35,39	,008	1,088	1,096		
40,11	– –	36,56	,006	1,085	1,091		
41,28	– –	37,73	,004	1,082	1,086		
42,45	– –	38,90	,002	1,080	1,082		

The intermediate ſpecific gravities may be found by taking an arithmetical mean between the ſpecific gravities by obſervation betwixt which that ſought lies, and noting how much it exceeds or falls ſhort of ſuch arithmetical mean; and then taking alſo an arithmetical mean betwixt the mathematical ſpecific

gravities betwixt which that sought for must lie, and a proportionate excess or defect.

I have added a column of attraction of the nitrous acid to water as far as it keeps pace with the increase of density, but no farther, as I am unacquainted with the law of its further increase.

The specific gravity of the strongest spirit of nitre yet made is, according to Mr. BAUME, 1,500; and according to Mr. BERGMAN, 1,586.

I next proceeded to examine the proportion of acid, water, and fixed alkali in nitre, in the same manner as I had before done that in digestive salt, and found that 100 gr. of perfectly dry nitre contain 28,48 gr. acid, 5,2 of water, and 66,32 of fixed alkali.

I shall now compare the result of these experiments with those of Mr. HOMBERG.

The specific gravity of the spirit of nitre which Mr. HOMBERG made use of was 1,349; and of this, he says, 1 oz. 2 dr. and 36 gr. that is, 621 Troy, are requisite to saturate 1 French (oz. 472,5 Troy) of dry salt of tartar; according to my computation 613 gr. are sufficient; for this specific gravity lies between the tabular specific gravities by observation 1,362 and 1,337, and is nearly an arithmetical mean between them. The corresponding mathematical specific gravity lies betwixt the tabular quantities 1,315 and 1,286, and is nearly 1,300. Now, the proportion of acid and water in this is, 2,629 of acid, and 7,465 of water; for $\frac{8,765}{1,200} = 7,465$ water and $= \frac{8,765 \times ,300}{1,200} = 2,629$ of acid; and the sum of both is 10,044. Now, since 10,5 gr. mild vegetable fixed alkali require 3,55 gr. of acid for their saturation,

472,5

472,5 will require 159,7; therefore, if 10,044 gr. of nitre contain 2,629 gr. acid, the quantity of this ſpirit of nitre requiſite to give 159,7 will be 613,2 nearly, and hence the difference betwixt us is only about 8 gr.

2dly. Mr. HOMBERG ſays, he found his ſalt, when evaporated to dryneſs, to weigh 186 gr. more than before; whereas, by my experiment, it ſhould weigh but 92,8 gr. more than at firſt. I ſhall mention the cauſe of this difference in treating of tartar vitriolate, for it cannot be intirely attributed to the difference of evaporation.

3dly. Mr. HOMBERG infers, that 1 oz. (that is, 472,5 Troy gr.) of this ſpirit of nitre contains 141 gr. Troy of real acid: by my computation it contains but 123,08 gr. of real acid. This difference evidently proceeds from his neglecting the quantity of water that certainly enters into the compoſition of nitre; for he proceeds on this analogy, 621 . 186,6 :: 472,5 . 141.

The proportion of fixed alkali I have aſſigned to nitre is fully confirmed by a very curious experiment of Mr. FONTANA's, inſerted in ROZIER's Journal for November 1778. This ingenious philoſopher decompoſed 2 oz. of nitre by diſtilling it in a ſtrong heat for eighteen hours. After the diſtillation there remained in the retort a ſubſtance purely alkaline, amounting to 10 French dr. and 12 gr. Now 2 French oz. = 944 gr. Troy, and the alkaline matter amounts to 607 gr. Troy; and, according to my computation, 944 gr. of nitre ſhould contain 625 of alkali. So ſmall a difference may fairly be attributed to the loſs in transferring from one veſſel to another, weighing, filtering, evaporating, &c.

Mr. LAVOISIER, in the Paris Memoirs for the year 1776, has given us, after Dr. PRIESTLEY, the analyſis of the nitrous acid.

In

In 2 oz. French meaſure (= 945 gr. Troy) of ſpirit of nitre, whoſe ſpecific gravity was 1,3160, he diſſolved 2 oz. and 1 dr. of mercury; the quantity of air obtained during the ſolution was 190 cubic inches French (= 202,55 Engliſh). This air was all nitrous. There remained a white mercurial ſalt, which, being diſtilled, afforded 12 cubic inches (= 12,785 Engliſh) of air mixed with red vapours, and which differed little from common air. There afterwards aroſe 224 cubic inches (= 238,56 Engliſh) of dephlogiſticated air, during the production of which, the mercury was almoſt revivified, there remaining but a few grains of a yellow ſublimate. The 12 inches of air mixed with red vapours aroſe, he ſays, from a mixture of 36 cubic inches of nitrous air (= 38,34 Engliſh) and 14 of dephlogiſticated air (14,91 Engliſh); and as the mercury was almoſt wholly revived, he concludes, theſe airs aroſe from the nitrous acid, and formed it; and hence infers, that 16 oz. of this ſpirit of nitre (= 7560 gr. Troy) contained 13 oz. 7 dr. 36$\frac{1}{2}$ gr. (that is, 6589 gr. Troy) of water, and conſequently only 971 gr. Troy of real acid, and therefore 2 oz. of this ſpirit of nitre contained but 120 gr. Troy of real acid: but, by my calculation, 2 oz. of this ſpirit of nitre contained 213 gr. acid; for its mathematical ſpecific gravity is 1,265. The ſame weight of acid will alſo be found in it by computing the weight of the volumes of the different airs he himſelf found it conſiſt of, or at leaſt to afford by its decompoſition; for 202,55 cubic inches of nitrous air weigh, by Mr. FONTANA's experiment, 80,8174 gr. Troy, and 238,56 inches of dephlogiſticated air weigh 100,1932 gr. Troy, and adding to theſe the weight of 38,34 inches of nitrous air, and of 14,91 of dephlogiſticated air, which made the 12 cubic inches of air mixed with red vapours, we ſhall find the whole weight of theſe airs to be 202,181 gr.;

the few grains wanting of 213 gr. may be accounted for from the abſorption of the water in which he received the airs, and by allowing for that ſtill remaining in the yellow ſublimate.

OF OIL OF VITRIOL.

The oil of vitriol I made uſe of was not perfectly dephlogiſticated; but though pale yet a little inclined to red. It contained ſome whitiſh matter, as I perceived by its growing milky on the affuſion of pure diſtilled water. How far this may alter the reſult of the following experiments I have not tried; but believe it to be as pure as that which is commonly uſed in all experiments, and therefore the fitteſt for my purpoſe.

To 2519,75 gr. of this oil of vitriol, whoſe ſpecific gravity was 1,819, I gradually added 180 gr. of diſtilled water, and ſix hours after found its ſpecific gravity to be 1,771.

To this mixture I again added 178,75 gr. of water, and found its ſpecific gravity, when cooled to the temperature of the atmoſphere, to be 1,719; it was then milky.

I then ſaturated the ſame quantity of the oil of tartar above mentioned with each of theſe ſorts of oil of vitriol in the manner already mentioned, and found the ſaturation to be effected (taking the medium of five experiments) by 6,5 gr. of that whoſe ſpecific gravity was 1,819; by 6,96 gr. of that whoſe ſpecific gravity was 1,771; and by 7,41 of that whoſe ſpecific gravity was 1,719.

I was obliged to add a certain proportion of water to each of theſe ſorts of oil of vitriol; for when they were not diluted, I perceived that part of the acid was phlogiſticated, and went off with the fixed air; but knowing the quantity of water that was added, it was eaſy to find, by the rule of proportion, the quantity

tity of each sort of oil of vitriol that was taken up by the alkali.

Hence I supposed, that each of these quantities of oil of vitriol of different densities contained 3,55 gr. of acid, as they saturated the same quantity of vegetable fixed alkali as 11 gr. of spirit of nitre, which contained that quantity of acid.

I then endeavoured to find the specific gravity of the pure vitriolic acid in the same manner as I before had that of the nitrous, as it cannot be had in the shape of air unless united to such a quantity of phlogiston as quite alters its properties. The loss of 6,5 gr. of oil of vitriol, whose specific gravity is 1,819 is $\frac{6,5}{1,819} = 3,572$; but as these 6,5 gr. contained, besides 3,55 gr. acid, 2,95 of water, the loss of this must be subtracted from the intire loss, and then the remainder 0,622 is the loss of the pure acid part in that state of density to which it is reduced by its union with water. The specific gravity therefore of the pure vitriolic acid in this state of density is $\frac{3,55}{0,622} = 5,707$. But to find its natural specific gravity we must find how much its density is increased by its union with this quantity of water: and, in order to observe this, I proceeded as before with the nitrous acid. 6,96 gr. of oil of vitriol, whose specific gravity was 1,771, contained 3,55 gr. acid, and 3,41 of water; then its specific gravity by calculation should be 1,726, for the loss of 3,55 gr. acid is $\frac{3,55}{5,707} = 0622$; the loss of 3,41 gr. water is 3,41; the sum of the losses 4,032. Then, $\frac{6,96}{4,032} = 17,261$; therefore the *accrued* density is 1,771 − 1,726 = ,045. Taking this therefore from 1,819, its mathematical specific gravity will be 1,774, then the loss of 6,5 gr. of oil of vitriol, whose

ſpecific gravity by obſervation is 1,819, will be found to be $\frac{6,5}{1,774} = 3,664$; but of this 2,95 gr. are the loſs of the water it contains, and the remainder 0,714 * are the loſs of the mere acid part. Then, $\frac{3,55}{0,715} = 4,9649$ is nearly the true ſpecific gravity of the pure vitriolic acid.

I then found the true increaſe of denſity ariſing from the union of the vitriolic acid and water in the foregoing mixtures, and obſerved, that in oil of vitriol, whoſe ſpecific gravity was 1,771, it was 0,84, and in that whoſe ſpecific gravity was 1,719, it was 0,100.

To obtain a ſynthetical proof of theſe deductions, I compared them with the ſpecific gravities of the firſt mixtures I had made; for if theſe deductions were true, the mathematical ſpecific gravities, and the *accrued* denſities, added to each other, ſhould amount to the ſame quantity as the ſpecific gravities by obſervation; and this I found to happen very nearly; for in the firſt experiment, where 2519,75 gr. of oil of vitriol, whoſe ſpecific gravity was 1,819, were mixed with 180 gr. of water, that oil of vitriol contained by my calculation 1376,171 gr. of acid and 1143,597 gr. of water, beſides the 180 gr. of water that were added to it, the loſs of the acid was $\frac{1376,171}{4,964} = 277,22$. The whole quantity of oil of vitriol was 2699,75 gr.; then the ſum of the loſſes was 1600,81; and therefore the mathematical ſpecific gravity $\frac{2699,75}{1600,81} = 1,686$; to which, adding ,084 the degree of accrued denſity, the ſpecific gravity by obſervation

* By miſtake, the following calculations were made on the ſuppoſition that the loſs was 0,715; the difference being immaterial, the calculations were not repeated.

ſhould be 1,770, which wants leſs than 1000th part in 2700 of being juſt.

Again: in the mixture, whoſe ſpecific gravity was 1,719 the ſum of the loſſes was 1779,549, and the weight of the whole 2878,4, the mathematical ſpecific gravity ſhould be $\frac{2778,400}{1779,549} = 1,617$, to which adding 0,100, the ſpecific gravity by obſervation ſhould be 1,717, which is nearly the truth.

By continuing theſe mixtures until the ſpecific gravities by calculation and obſervation nearly coincided, I formed the following table. The extra-tabular proportions are to be ſought in the manner already ſhewn; the two firſt ſeries were formed by analogy.

Oil and spirit of vitriol.	Acid.	Water.	Accrued denſity.	Mathematical ſpecific gravity.	Specific gravity by obſervation	Attract. of the acid to water.	Attract. of water to the acid.
Grs.	Grs.	Grs.					
5,58	– –	2,03	,000	2,032	2,032	,005	0,140
6,04	– –	2,49	,005	1,884	1,889	,045	0,149
6,5	– –	2,95	,045	1,774	1,819	,084	0,139
6,96	– –	3,41	,084	1,687	1,771	0,100	0,137
7,41	– –	3,86	0,100	1,619	1,719	0,112	0,129
7,87	– –	4,32	0,112	1,563	1,675	0,122	0,122
8,33	– –	4,78	0,122	1,515	1,637	0,129	0,112
8,79	– –	5,24	0,129	1,476	1,605	0,137	0,100
9,25	– –	5,70	0,137	1,441	1,578	0,139	,084
9,71	– –	6,16	0,139	1,412	1,551	0,149	,045
10,17	– –	6,67	0,140	1,385	1,525	,0140	,005
10,63	– –	7,08	0,139	1,363	1,502		
11,09	– –	7,54	0,132	1,343	1,475		
11,55	– –	8,00	0,127	1,325	1,452		
12,01	– –	8,46	0,120	1,308	1,428		
12,47	– –	8,92	0,113	1,294	1,407		
12,93	– –	9,38	0,106	1,280	1,386		
13,39	– –	9,84	0,100	1,268	1,368		
13,85	– –	10,30	0,094	1,257	1,351		
14,31	– –	10,76	0,088	1,247	1,335		
14,77	– –	11,22	0,83	1,237	1,320		
15,23	– –	11,68	,078	1,228	1,306		
15,69	3,55	12,14	,074	1,220	1,294		
16,15	– –	12,60	,070	1,212	1,282		
16,61	– –	13,06	,066	1,205	1,271		
17,07	– –	13,52	,062	1,199	1,261		
17,53	– –	13,98	,059	1,191	1,250		
17,99	– –	14,44	,056	1,187	1,243		
18,45	– –	14,90	,053	1,181	1,234		
18,91	– –	15,36	,050	1,176	1,226		
19,37	– –	15,82	,047	1,167	1,214		
19,83	– –	16,28	,044	1,166	1,210		
20,29	– –	16,74	,040	1,162	1,203		
20,75	– –	17,20	,038	1,158	1,196		
21,21	– –	17,66	,035	1,154	1,189		
21,67	– –	18,12	,032	1,150	1,182		
22,13	– –	18,58	,029	1,146	1,175		
22,59	– –	19,04	,026	1,143	1,169		
23,05	– –	19,50	,023	1,140	1,163		
23,51	– –	19,96	,020	1,137	1,157		
23,97	– –	20,42	,018	1,134	1,152		
24,43	– –	20,88	,016	1,131	1,147		
24,89	– –	21,34	,014	1,128	1,142		
25,35	– –	21,80	,012	1,125	1,137		
25,81	– –	22,26	,010	1,123	1,133		
26,27	– –	22,72	,008	1,120	1,128		
26,73	– –	23,18	,006	1,118	1,124		
27,19	– –	23,64	,004	1,116	1,120		
27,65	– –	24,10	,002	1,114	1,116		

The specific gravity of the most concentrated oil of vitriol yet made is, according to Mr. BAUME and BERGMAN, 2,125.

I ascertained the proportion of acid water and fixed alkali in tartar vitriolate, as before, in nitre and digestive salt. I found the salts, resulting from the saturation of the same oil of tartar, with portions of oil of vitriol of different specific gravities, to weigh, at a medium, 12,45 gr. Of this weight only 11,85 gr. were alkali and acid, the remainder therefore was water, *viz.* 0,6 of a grain; consequently 100 gr. of perfectly dry tartar vitriolate contain 28,51 gr. acid, 4,82 of water, and 66,67 of fixed vegetable alkali. Note, in drying this salt I used a heat of 240° to expel the adhering acid more thoroughly. I kept it in that heat a quarter of an hour.

According to Mr. HOMBERG, 1 French oz. (or 472,5 gr. Troy) of dry salt of tartar required 297,5 gr. Troy of oil of vitriol, whose specific gravity was 1,674, to saturate it; but, by my calculation, this quantity of fixed alkali would require 325 gr.: a difference which, considering our different methods of determining the specific gravity of liquids (his method, *viz.* that by mensuration, giving it always less than mine) the different deflecation of our alkalies, &c. may pass for inconsiderable.

The resulting salt weighed, according to Mr. HOMBERG, 182 gr. Troy above the original weight of the fixed alkali; but by my experiment it should weigh but 87,7 gr. more; for :: 10,5 . 12,45 :: 472,5 . 560,2. It is hard to say how Mr. HOMBERG could find this great excess of weight both in nitre and tartar vitriolate, unless he meant by the *original weight* of the salt of tartar the weight of the mere alkaline part, distinct from the fixed air it contained: and indeed one would be tempted to think, he did make this distinction; for in that

ca e the exceſs of weight will be very nearly ſuch as he determined it: for :: 10,5 . 8,3 :: 472,5 . 373,3. Now, the whole weight of his nitre was 560,2, as I have above ſhewn: then 560,2 − 373,3 = 116,9, which is only 4 gr. more than he determined it.

Hence he inferred, that 1 oz. (472,5 gr. Troy) of this oil of vitriol contains 291,7 gr. of acid. By my computation it contains but 213,3; but it muſt be conſidered, he made no allowance for the water contained in tartar vitriolate, and imagined the whole of the increaſe of weight proceeded from the acid that is united in it to the fixed alkali. Now the aqueous part in 560 gr. of tartar vitriolate amounts to 37 gr. the remaining difference may be attributed to the different degrees of deſiccation, &c.

OF THE ACETOUS ACID.

I have made no experiment on this acid; but, by calculating from the experiment of Mr. HOMBERG, I find the ſpecific gravity of the pure acetous acid, free from ſuperfluous water, ſhould be 2,130. It is probable, its affinity to water is not ſtrong enough to cauſe any irregular increaſe in its denſity, at leaſt that can be expreſſed by three decimals; and hence its proportion of acid and water may always be calculated from its ſpecific gravity and abſolute weight.

100 parts of foliated tartar, or (as it ſhould rather be called) acetous tartar, contain well dried 32 of fixed alkali, 19 of acid, and 49 parts of water.

The ſpecific gravity of the ſtrongeſt concentrated vinegar yet made is 1,069.

It

It is harder to find the point of saturation with the vegetable than with the mineral acids; because they contain a mucilage that prevents their immediate union with alkalies, and hence they are commonly used in too great quantity. They should be used moderately hot, and sufficient time allowed them to unite.

From these experiments it follows:

1st. That fixed vegetable alkalies take up an equal quantity of the three mineral acids, and probably of all pure acids; for we have seen, that 8,3 grains of pure vegetable alkali (that is, free from fixed air) take up 3,55 gr. of each of these acids, and consequently 100 parts of caustic fixed alkali would require 42,4 parts of acid to saturate them. Now, Mr. BERGMAN has found, that 100 parts of caustic fixed vegetable alkali take up 47 parts of the aerial acid, which, considering his alkali might contain some water, differs but little from my calculation. It should therefore seem, that alkalies have a certain determinate capacity of uniting to acids, that is, to a given weight of acids; and that this capacity is equally satiated by that given weight of any pure acid indiscriminately. This weight is about 2,35 of the weight of the vegetable alkali.

2dly. That the three mineral acids, and probably all pure acids, take up 2,253 times their own weight of pure vegetable alkali, that is, are saturated by that quantity.

3dly. That the density accruing to compound substances from the union of their component parts, and exceeding its mathematical ratio, increases from a *minimum*, when the quantity of one of them is very small in proportion to that of the other, to a *maximum*, when their quantities differ less; but that the attraction, on the contrary, of that part which is in the smallest quantity to that which is in the greater, is at its

maximum when the accrued denſity is at its *minimum*, but not reciprocally; and hence the point of ſaturation is probably the *maximum* of denſity and the *minimum* of ſenſible attraction of one of the parts. Hence no decompoſition operated by means of a ſubſtance that has a greater affinity with one part of a compound than with the other, and than theſe parts have to each other, can be complete, unleſs the *minimum* affinity of this third ſubſtance be greater than the *maximum* affinity of the parts already united. Hence few decompoſitions are complete without a double affinity intervenes; and hence the laſt portion of the ſeparated ſubſtance adheres ſo obſtinately to that to which it was firſt united, as all chemiſts have obſerved. Thus, though acids have a greater affinity to phlogiſton than the earths of the different metals have to it, yet they can never totally dephlogiſticate theſe earths but only to a certain degree; ſo though atmoſpheric air, and particularly dephlogiſticated air, attracts phlogiſton more ſtrongly than the nitrous acid does; yet not even dephlogiſticated air can deprive the nitrous acid totally of its phlogiſton, as is evident from the red colour of the nitrous acid when nitrous air and dephlogiſticated air are mixed together. Hence alſo mercury precipitated from its ſolution in any acid, even by fixed alkalies, conſtantly retains a portion of the acid to which it was originally united, as Mr. BAYEN has ſhewn; ſo alſo does the earth of allum, when precipitated in the ſame manner from its ſolution; and thus ſeveral anomalous decompoſitions may be explained. Indeed, I have reaſon to doubt, whether mercury does not attract acids more ſtrongly than alkalies attract them.

4thly. That concentrated acids are, in ſome meaſure, phlogiſticated, and evaporate by union with fixed alkalies.

5thly.

5thly. That, knowing the quantity of fixed alkali in oil of tartar, we may determine the quantity of real pure acid in any other acid substance that is difficultly decomposed, as the sedatif acid, and those of vegetables and animals; for 10,5 gr. of the mild alkali will always be saturated by 3,55 gr. of real acid: and reciprocally, the quantity of acid in any acid liquor being known, the quantity of real alkali in any vegetable alkaline liquor may be found.

OF THE SPECIFIC GRAVITY OF FIXED AIR IN ITS FIXED STATE.

Being desirous to know the specific gravity of some substances which are difficultly procured, or at least preserved for any time, free from fixed air, such as fixed and volatile alkalies, I was induced to seek the specific gravity of the former in its fixed state as of an element necessary to the calculation of the latter; it being very evident, that its density, in its fixed state, must be very different from that which it possesses in its fluid elastic state.

I therefore took a piece of white marble, of the purest kind, which weighed 440,25 gr. and weighing it in water, found it to lose 162 gr.; its specific gravity was therefore 2,7175.

Of this marble, reduced to a fine powder, I put 180 gr. into a phial, and expelling the fixed air by the dilute vitriolic acid and heat, I found its quantity amount to 105,28 cubic inches; the thermometer being at 65°, and the barometer between 29 and 30 inches, this bulk of air would, at 55° of FAHRENHEIT, occupy but 102,4 cubic inches; at which temperature, according to the experiment of Mr. FONTANA, a

cubic inch of fixed air (the barometer being at 29°1) would weigh 0,57 of a grain; therefore the weight of the whole quantity of fixed air amounted to 58,368 gr. which is nearly one third of the weight of the marble. At this rate, 100 gr. of the marble contained 32,42 of fixed air.

To determine the proportion of water and calcareous earth, and alſo the ſpecific gravity of this latter, I put 3009,25 gr. of the ſame marble finely powdered into a crucible, looſely covered; the crucible and its contents, before calcination, weighed 8394 gr. and after remaining fourteen hours in a white heat I found it to weigh 7067,5 gr. The weight of the crucible alone was 5384,75 gr.; therefore the weight of the lime ſingly was 1682,75 gr. The marble then loſt by calcination 1326,5 gr.; 180 gr. of the marble ſhould then loſe 79,343 gr. and 100 gr. ſhould loſe 44,08; but of theſe 44,08, 32,42 were fixed air, as is already ſeen, therefore the remainder, that is, 11,66 gr. were water, and the quantity of pure calcareous earth in 100 gr. of the marble was 55,92 gr.

I next proceeded to diſcover the ſpecific gravity of the lime.

Into a braſs box, which weighed 607,65 gr. and in the bottom of which a ſmall hole was drilled, I ſtuffed as much as poſſible of the finely powdered lime, and then ſcrewed the cover on, and weighed it both in air and water. When immerſed in this latter, a conſiderable quantity of common air was expelled; when this ceaſed, I weighed it. The reſult of this experiment was as follows:

	Gr.
Weight of the box in air	607,65
Its loss of weight in water	78,750
Weight of the box and lime in air	1043,5
Weight of the lime singly in air	435,85
Loss of weight of the box and lime in water	256,5
Loss of weight of the lime singly	182,3.

Hence, dividing the absolute weight of the lime by its loss in water, its specific gravity was found to be 2,3908.

From these *data* I deduced the specific gravity of fixed air in its fixed state; for 100 gr. of marble consist of 55,92 of earth, 32,42 of fixed air, and 11,66 of water; and the specific gravity of the marble is 2,717. Now, the specific gravity of the fixed air, in its fixed state, is as its absolute weight divided by its loss of weight in water; and its loss of weight in water is as the loss of 100 gr. of marble *minus* the losses of the pure calcareous earth and of the water.

Loss of 100 gr. of marble $= \frac{100}{2,717} = 36,8$ gr.

Loss of 55,92 gr. calcareous earth $= \frac{55,92}{2,390} = 23,39$ gr.

Loss of 11,66 gr. water $= 11,66$

$35,05$

Then the loss of the fixed air $36,8 - 35,05 = 1,75$; consequently, its specific gravity is $\frac{32,42}{1,75} = 18,52$; by which it appears to be the heaviest of all acids, or even of all bodies yet known, gold and platina excepted.

OF

OF FIXED VEGETABLE ALKALI.

As the manner of conducting the experiments I made on this ſalt was nearly the ſame as that I uſed in the foregoing (except that to find its ſpecific gravity I weighed it in æther inſtead of water), I ſhall content myſelf, to avoid the repetition of tedious calculation, with relating the reſult of theſe experiments.

1ſt. I found that 100 gr. of this alkali contain about 6,7 gr. of earth, which, according to Mr. BERGMAN, is ſiliceous: this earth paſſes the filter with it when the alkali is not ſaturated with fixed air, ſo that it ſeems to be held in ſolution as in *liquor ſilicum*.

2dly. I found, that the quantity of fixed air in oil of tartar and dry vegetable fixed alkali is various at various times and in various parcels of the ſame ſalt; but that at a medium in the purer alkalies it may be rated at 21 gr. in 100; and hence the quantity of this alkali in any ſolution of it may be very nearly gueſſed at, by adding a known weight of a dilute acid to a given weight of ſuch ſolution, and then weighing it again; for as 21 is to 100, ſo is the weight loſt to the weight of mild alkali in ſuch ſolution.

The ſpecific gravity of mild and perfectly dry four times calcined fixed alkali, free from ſiliceous earth, and containing 21 *per cent.* of fixed air, I found to be 5,0527.

When it contains more fixed air, its ſpecific gravity is probably higher, except it were not perfectly dry: from whence I inferred the ſpecific gravity of this alkali, when cauſtic and free from water, to be 4,234.

From the weight of the aerial acid, in its fixed ſtate, it happens, that fixed alkalies, when united to it, are ſpecifically heavier than when united either to the vitriolic or nitrous acids. Thus Mr. R. WATSON, in the Phil. Tranſ. for the year 1770, p. 337. found the ſpecific gravity of dry ſalt of tartar (including ſiliceous earth) to be 2,761: whereas the ſpecific gravity of tartar vitriolate was only 2,636, and that of nitre 1,933. The reaſon why nitre is ſo much lighter than tartar vitriolate, is, becauſe it contains much more water, and its union with the alkali is leſs intimate.

Laſtly, I have drawn up a table of the quantity of mild alkali, containing 6,7 *per cent.* of earth (which is its uſual degree of purity) to be found in natural or artificial ſolutions of this alkali, the thermometer at 63°; and though it is not quite accurate, wanting about 1,1 *per cent.* of the truth, yet, I preſume, it may be found uſeful, as this error is eaſily corrected.

Table

Table of the contents of a solution of mild vegetable alkali, according to its specific gravity.

Gr. of the solution.	Gr. of alkali.	Gr. of water.	Accrued density.	Mathematical specific gravity.	Specific gravity by observation
62,92	– –	38,67	,030	1,445	1,495
70,60	– –	44,35	,049	1,393	1,446
76,28	– –	50,03	,048	1,356	1,404
81,96	– –	55,71	,047	1,324	1,371
87,64	– –	61,39	,046	1,297	1,343
93,32	– –	67,07	,045	1,274	1,319
99,00	– –	72,75	,044	1,254	1,298
104,68	– –	78,43	,043	1,237	1,280
110,36	– –	84,11	,042	1,223	1,265
115,98	– –	89,79	,041	1,209	1,250
121,66	– –	95,4	,040	1,198	1,238
127,34	– –	101,15	,039	1,187	1,226
133,02	– –	106,83	,038	1,178	1,216
138,7	– –	112,51	,037	1,170	1,207
144,3	– –	118,19	,036	1,162	1,198
149,98	– –	123,87	,035	1,155	1,190
155,66	– –	129,55	,034	1,149	1,183
161,34	– –	135,23	,033	1,143	1,176
167,02	26,25	140,91	,032	1,138	1,170
172,70	– –	146,59	,031	1,132	1,163
178,38	– –	152,27	,030	1,128	1,158
184,06	– –	157,95	,029	1,123	1,152
189,74	– –	163,63	,028	1,119	1,147
195,42	– –	169,31	,027	1,115	1,142
201,10	– –	174,99	,026	1,112	1,138
206,78	– –	180,67	,025	1,108	1,133
212,46	– –	186,35	,024	1,105	1,129
218,14	– –	192,03	,023	1,100	1,123
223,82	– –	197,71	,022	1,099	1,121
229,50	– –	203,39	0,21	1,097	1,118
235,18	– –	209,07	,020	1,094	1,114
240,86	– –	214,75	0,19	1,092	1,111
246,54	– –	220,43	,018	1,089	1,107
252,12	– –	226,11	0,17	1,087	1,104
257,80	– –	231,79	,016	1,085	1,101
263,48	– –	237,47	,015	1,083	1,098
269,16	– –	243,15	,014	1,081	1,095

Gr. of the ſolution.	Gr. of alkali.	Gr. of water.	Accrued denſity.	Mathematical ſpecific gravity.	Specific gravity by obſervation
274,78	– –	248,83	,013	1,079	1,092
280,46	– –	254,51	,012	1,077	1,089
286,14	– –	260,19	,011	1,076	1,087
291,82	– –	265,87	,010	1,074	1,084
297,50	– –	271,55	,009	1,070	1,079
303,18	– –	277,23	,008	1,069	1,077
308,86	26,25	282,91	,007	1,068	1,075
314,54	– –	288,59	,006	1,066	1,072
319,22	– –	294,27	,005	1,065	1,070
324,90	– –	300,45	,004	1,064	1,068
330,58	– –	306,13	,003	1,063	1,066
336,26	– –	311,81	,002	1,062	1,064
341,94	– –	317,49	,001	1,061	1,062

Impure vegetable fixed alkalies ſuch as pearl aſh, pot aſhes, &c. contain more fixed air, as appears by the experiments of Dr. LEWIS. Pearl aſh, according to Mr. CAVENDISH, contains 28,4 or 28,7 *per cent.* of fixed air. Hence in lyes of equal ſpecific gravity with thoſe of a purer alkali, the quantity of ſaline matter will be more probably in the ratio of 28,4 or 28,7 to 21; but this ſurplus weight is only fixed air; and hence even in theſe lyes the quantity of depurated ſalt they will afford will be found by the above table. Much alſo depends on their age, the oldeſt containing moſt fixed air.

III. *Account of the violent Storm of Lightning at* East-bourn, *in* Suſſex, Sept. 17, 1780; *communicated by* Owen Salusbury Brereton, *Eſq. F. R. and A. S.*

Read December 14, 1780.

SIR,

I AM deſired by my friend and neighbour JAMES ADAIR, Eſq. of Soho Square, to communicate to you an account of the dreadful accident which happened to him and his family at East-bourn, in the county of Suſſex, at nine o'clock in the morning, on Sunday the ſeventeenth of September laſt. He rented a houſe which ſtood by itſelf, built of various ſorts of ſtone, three ſtories high, and facing the ſea, which was nearly South-eaſt of it. The morning was very ſtormy, with rain, thunder, and lightning; and juſt at nine o'clock a horrid black cloud appeared, out of which Mr. ADAIR ſaw ſeveral balls of fire drop into the ſea ſucceſſively, as he was approaching the window in a one-pair of ſtairs room; and very ſoon after, as he was ſtanding at it with his hands claſped, and extended open againſt the middle of the frame, a moſt violent flaſh of fire forced his hands aſunder, and threw him ſeveral yards upon the floor on his back, with both his legs upright in the air, which remained long ſo fixed. He was very ſenſible of his ſituation all the time, but could not open his eyes or ſpeak; nor had he the leaſt power of motion of any of his limbs for a long time. On

help coming in, and examining his cloaths, which were blue cloth, his right ſleeve, both of coat and waiſtcoat, and alſo ſhirt, were all torn on the inſide of the arm entirely open, as if by a dog, from the ſhoulder to the wriſt; the right-ſide of the breeches was torn in the ſame manner, and part of each of the braſs buttons melted.

He had in his fob a gold watch with a ſteel chain; the button which opens it and three other places of the caſe were melted. The pendant to which the chain is fixed was almoſt melted through, and much of the ſteel chain is incorporated with it, as is reciprocally ſome gold on that part of the ſteel which was within the fob. The going of the watch had ſtopped inſtantaneouſly, occaſioned, as at firſt appeared by the ſmall pendulum ſpiral ſteel ſpring having been lengthened; not that it was abſolutely ſo, but relatively, reſpecting the ſcapement of the watch, the ſeveral inner turns being brought cloſer together.

His right-arm, right-ſide, and thigh, were miſerably ſcorched, and the fleſh torn: the foot of the ſtocking of his right leg and his ſhoe were torn in ſeveral places between the buckle and the toe-end of the ſhoe, and one of his toes ſplit almoſt to the bone; but the buckle, which was a broad ſilver one, was not the leaſt hurt or even marked, and remained buckled as before. His ſleeve-button of gold, in which was platted hair covered with cryſtal, was broken from its link, and neither hair or cryſtal have been found ſince. A key and a pen-knife in his right-ſide breeches pocket have ſeveral marks of fuſion upon them.

The frame of the window on which Mr. ADAIR was leaning was little damaged; but every pane of glaſs ſo completely ſmaſhed, you could ſcarce perceive it had ever had glaſs in it. The room was ſtuccoed and papered, and between the windows hung a large pier glaſs, which, with much of the ſtucco, was ſhivered to pieces, and ſtrewed over the floor. A door oppoſite the window

was ſhattered to pieces, and the poſts of a bed in a room behind it, and all the bell-wires were deſtroyed.

Under the dining-room Mr. ADAIR was in, on the parlour floor, were his coachman, butler, and footman. The coachman was going to open a glaſs-door to go towards the ſea, and was ſtruck dead. His body was totally black. His cloaths, and the caul of his wig, and cravat, were much torn; but no particular fleſh wound was found. The enamelled face of his ſilver watch was broken to pieces, and the links of his ſteel chain faſtened together.

The footman was dreſſing his hair near a window, when he was thrown dead on the ground. He appeared much ſcorched, bruiſed, and black. He had a very large wound in his ſide which penetrated near his heart; but very little, if any, blood came from it. His buck-ſkin breeches were much torn, and the ſteel of a metal knee-buckle driven through them. The window ſaſh was driven into the room, and a ſtone, about eight inches ſquare, forced out of the wall into the middle of the room, not far from the body. The butler was a yard or two behind the coachman, and going out with a teleſcope in his hand, which was forced in pieces from him, his hat and wig were thrown to ſome diſtance, and he perceived a violent preſſure on his ſkull and on his back, but was no otherwiſe hurt. He had a ſilver watch with a ſilver chain, which received no damage.

In the room over Mr. ADAIR's, a young lady was dreſſing, and her maid attending. They were both driven to a diſtant part of the room, and rendered inſenſible for ſome time, but not hurt. The poſts of the bed ſhe had juſt left were all ſhivered to pieces, and the bell wires deſtroyed, and the chimney thrown down on the roof.

It is to be remarked, that though the bodies of the two ſervants lay unburied from the Sunday till Tueſday, all their limbs were as entirely flexible as thoſe of a living perſon.

Multitudes on the ſhore before the houſe ſaw the meteor dart in a right line over their heads, and break againſt the front of the houſe in different directions, and all agreed the form and flame was exactly like that of an immenſe ſky-rocket.

IV. *An Account of the* Harmattan, *a ſingular* African *Wind.* *By* Matthew Dobſon, *M. D. F. R. S.*; *communicated by* John Fothergill, *M. D. F. R. S.*

Read December 7, 1780.

THE Harmattan is a periodical wind which blows from the interior parts of Africa towards the Atlantic Ocean, and poſſeſſes ſuch extraordinary properties, as to merit the attention of the naturaliſt, making a curious and important article in the hiſtory and theory of the winds.

The firſt information I had on this ſubject was from my friend Mr. NORRIS, who has frequently viſited the Coaſt of Africa, and is a gentleman of an excellent underſtanding and ſtrict veracity. This information immediately excited my attention; and as Mr. NORRIS was preparing to make another voyage to that part of the world, I deſired him to confirm the facts which he had related, by further inquiries, experiments, and obſervations; and it is from theſe materials, with which I have been obligingly furniſhed by Mr. NORRIS, that the following account is drawn up.

On that part of the Coaſt of Africa which lies between Cape Verd and Cape Lopez, an eaſterly wind prevails during the months of December, January, and February, which by the Fantees, a nation on the Gold Coaſt, is called the Harmattan. Cape Verd is in 15° N. latitude, and Cape Lopez in 1° S. latitude, and the coaſt between theſe two Capes runs, in an oblique direction,

direction, nearly ſtom W.S.W. to E.S.E. forming a range of upwards of two thouſand one hundred miles. At the Iſles de Los, which are a little to the northward of Sierra Leone, and to the Southward of Cape Verd, it blows from the E.S.E. on the Gold Coaſt from the N.E. and at Cape Lopez and the River Gabon from the N.N.E. This wind is, by the French and Portugueze who frequent the Gold Coaſt, called ſimply the N.E. wind, the quarter from which it blows. The Engliſh, who ſometimes borrow words and phraſes from the Fantee language, which is leſs guttural and more harmonious than that of their neighbours, adopt the Fantee word Harmattan.

The Harmattan comes on indiſcriminately at any hour of the day, at any time of the tide, or at any period of the Moon, and continues ſometimes only a day or two, ſometimes five or ſix days, and it has been known to laſt fifteen or ſixteen days. There are generally three or four returns of it every ſeaſon. It blows with a moderate force, not quite ſo ſtrong as the ſea breeze (which every day ſets in during the fair ſeaſon from the W. W.S.W. and S.W.); but ſomewhat ſtronger than the land wind at night from the N. and N.N.W.

1. *A fog or haze* is one of the peculiarities which always accompanies the Harmattan. The gloom occaſioned by this fog is ſo great, as ſometimes to make even near objects obſcure. The Engliſh fort at Whydah ſtands about the midway between the French and Portugueſe forts, and not quite a quarter of a mile from either, yet very often from thence neither of the other forts can be diſcovered. The ſun, concealed the greateſt part of the day, appears only about a few hours about noon, and then of a mild red, exciting no painful ſenſation on the eye.

As the particles which conſtitute the fog are depoſited on the graſs, the leaves of trees, and even on the ſkin of the negroes, ſo

ſo as to make them appear whitiſh, I recommended to Mr. NORRIS the uſe of a good microſcope, as this might poſſibly diſcover ſomething concerning the nature of theſe particles. "I was prevented," ſays Mr. NORRIS, "by the bad ſtate of "my health from availing myſelf of the microſcope; neither "could I diſcover any thing by the taſte, or by expoſing plates "covered thinly with melaſſes, for when I had dropped an acid "or alkali into the water in which I had diſſolved the melaſſes, "nothing followed to enable me to judge of the nature "of the particles. Surely they cannot be inſects, or ani-"malculæ of inſects? for we have no appearance of any "thing produced from the myriads of them which are depoſited "on the earth. They do not flow far over the ſurface of the "ſea: at two or three miles diſtance from the ſhore the fog is "not ſo thick as on the beach; and at four or five leagues diſ-"tance it is intirely loſt, though the Harmattan itſelf is plainly "felt for ten or twelve leagues, and blows freſh enough to alter "the courſe of the current."

2. *Extreme dryneſs* makes another extraordinary property of this wind. No dew falls during the continuance of the harmattan; nor is there the leaſt appearance of moiſture in the atmoſphere. Vegetables of every kind are very much injured; all tender plants, and moſt of the productions of the garden, are deſtroyed; the graſs withers, and becomes dry like hay; the vigorous ever-greens likewiſe feel its pernicious influence; the branches of the lemon, orange, and lime trees droop, the leaves become flaccid, wither, and, if the harmattan continues to blow for ten or twelve days, are ſo parched as to be eaſily rubbed to duſt between the fingers: the fruit of theſe trees, deprived of its nouriſhment, and ſtinted in its growth, only appears to ripen, for it becomes yellow and dry, without acquiring

acquiring half the uſual ſize. The natives take this opportunity of the extreme dryneſs of the graſs and young trees to ſet fire to them, eſpecially near their roads, not only to keep thoſe roads open to travellers, but to deſtroy the ſhelter which long graſs, and thickets of young trees, would afford to ſkulking parties of their enemies. A fire thus lighted flies with ſuch rapidity as to endanger thoſe who travel; in that ſituation a common method of eſcape is, on diſcovering a fire to windward, to ſet the graſs on fire to leeward, and then follow your own fire. There are other extraordinary effects produced by the extreme dryneſs of the Harmattan. The covers of books, Mr. NORRIS informs me, even cloſely ſhut up in a trunk, and lying among his cloaths, were bent as if they had been expoſed to the fire. Houſhold furniture is alſo much damaged: the pannels of doors and of wainſcot ſplit, and any veneered work flies to pieces. The joints of a well-laid floor of ſeaſoned wood open ſufficiently to lay one's finger in them; but become as cloſe as before on the ceaſing of the Harmattan. The ſeams alſo in the ſides and decks of ſhips are much injured and become very leaky, though the planks are two or three inches in thickneſs. Iron-bound caſks require the hoops to be frequently driven tighter; and a caſk of rum or brandy, with wooden hoops, can ſcarcely be preſerved; for, unleſs a perſon attends to keep it moiſtened, the hoops fly off.

The parching effects of this wind are likewiſe evident on the external parts of the body. The eyes, noſtrils, lips, and palate, are rendered dry and uneaſy, and drink is often required, not ſo much to quench thirſt, as to remove a painful aridity in the *fauces*. The lips and noſe become ſore, and even chapped; and though the air be cool, yet there is a troubleſome ſenſation of prickling heat on the ſkin. If the Harmattan continues

four or five days, the ſcarf ſkin peels off, firſt from the hands and face, and afterwards from the other parts of the body, if it continues a day or two longer. Mr. NORRIS obſerved, that when ſweat was excited by exerciſe on thoſe parts which were covered by his cloaths from the weather, it was peculiarly acrid, and taſted, on applying his tongue to his arm, ſomething like ſpirit of hart's-horn diluted with water.

As the ſtate of ſalt of tartar placed in the open air, and the quantity evaporated from a given ſurface of water, are obvious proofs of the comparative moiſture or dryneſs of the atmoſphere, I deſired Mr. NORRIS to put the Harmattan to each of theſe teſts; and particularly to moiſten ſalt of tartar *ad deliquium*, and expoſe it to the night air during the time that the Harmattan was blowing. The following is the account of the reſult of theſe experiments. Salt of tartar will not only remain dry during the night as well as in the day; but, when liquified ſo as to run upon a tile, and expoſed to the Harmattan, becomes perfectly dry in two or three hours; and, expoſed in like manner to the night air, will be dry before morning.

With reſpect to evaporation Mr. NORRIS ſays, "I fixed the "tin veſſel, with which you favoured me, on a graſs plat "behind my houſe, upon a ſtand four feet high, and expoſed "by its ſituation moſt part of the day to the ſun, but ſhel-"tered in ſome meaſure from the wind by the houſe."

Day

Day of the Month.	Evaporation of one tenth of an inch.	Thermometer 6 Morn.	1 Noon.	6 Even.	Remarks.
		°	°	°	Light breeze and hazy.
Nov. 27	1½	–	–	–	Ditto and fair weather.
28	2	–	–	–	Hazy with regular land and sea breezes.
29	2	–	–	–	Ditto.
30	1½	–	–	–	Ditto.
Dec. 1	1½	–	–	–	Fresh breezes and fair.
2	2 Day. Night.	76	80	79	Harmattan began to blow moderately.
3	2 1	74	76	75	Harmattan still blowing, but moderately, and the fog not considerable.
4	2½ 1½	75	77	76	Harmattan almost over.
5	2 1	74	76	76	Harmattan over, sea breeze as usual, hazy.
6	2	76	80	78	Light breeze and hazy.
7	2	76	80	78	Ditto.
8	2	76	80	78	

"The thermometer hung in a large warehouse near a win-
"dow on which the sun never came at that season of the year,
"as it had a north aspect, and where little reflected heat came,
"a grass plat being before it. When removed into the next
"room, which had three windows and a door opening into the
"parade, the thermometer usually rose 4° higher than it did in
"the warehouse; its general height in the room, from one to
"three o'clock, was 84°.

"On the 14th of December, when there was no Harmattan,
"the thermometer at noon, on putting it into the evaporating
"vessel, rose to 88°; on taking it out, it sunk to 79°, whilst the
"moisture on its surface was evaporating; but on exposing it
"five minutes to the sun it rose to 102°. On the fifteenth of
"December the thermometer, exposed to the wind in my

" room window, but not to the ſun, ſtood at noon at 84°; at " 88° in the evaporating veſſel; ſunk to 80° as the water eva- " porated from its ſurface; roſe in the ſun in ſix minutes to " 104°; and, on putting it into the water-jar in my room, " ſunk to 76°."

It appears from the preceding experiments made by Mr. NORRIS, that, if the evaporation of the whole year be ſuppoſed to go on in the ſame proportion with what occurred during a ſhort and very moderate return of the Harmattan, the annual Harmattan evaporation would be 133 inches; and if the calculation was made in proportion to the evaporation which occurs during a longer viſit from the Harmattan, and a more forcible breeze, the annual Harmattan evaporation would be much more conſiderable. If the annual evaporation be in like manner calculated, in proportion to the evaporation which took place ſubſequent to and preceding the Harmattan, the annual evaporation at Whydah on the Gold Coaſt would be 64 inches, and I have found the annual evaporation at Liverpool to be 36 inches *. Theſe three therefore are in the following proportion; Harmattan 133 inches, Whydah 64 inches, and Liverpool 36 inches.

As the names of things are often derived from ſome remarkable property in the thing denoted, I deſired Mr. NORRIS to inquire into the derivation of the word Harmattan. He found it to be a corruption of *Aberramantah*, the name of that ſeaſon in which this wind blows. Aherramantah is compounded of *Aberraman*, which in the Fantee language ſignifies to blow, and *tah*, tallow or greaſe, with which the natives rub their ſkins to prevent their growing dry and rough.

* Philoſophical Tranſactions, vol. LXVII. p. 252.

The Harmattan ſeaſon is in the Dunco language called *Pep-peh*, ſignifying a dry and rough ſkin.

3. *Salubrity* forms a third peculiarity of the Harmattan. Though this wind is ſo very prejudicial to vegetable life, and occaſions ſuch diſagreeable parching effects on the human ſpecies, yet it is highly conducive to health. Thoſe labouring under fluxes and intermitting fevers generally recover in an Harmattan. Thoſe weakened by fevers, and ſinking under evacuations for the cure of them, particularly bleeding, which is often injudiciouſly repeated, have their lives ſaved, and vigour reſtored, in ſpite of the doctor. It ſtops the progreſs of epidemics: the ſmall-pox, remittent fevers, &c. not only diſappear, but thoſe labouring under theſe diſeaſes when an Harmattan comes on, are almoſt certain of a ſpeedy recovery. Infection appears not then to be eaſily communicated even by art. In the year 1770 there were on board the Unity, at Whydah, above 300 ſlaves; the ſmall-pox broke out among them, and it was determined to inoculate; thoſe who were inoculated before the Harmattan came on got very well through the diſeaſe. About ſeventy were inoculated a day or two after the Harmattan ſet in; but not one of them had either ſickneſs or eruption. It was imagined, that the infection was effectually diſperſed, and the ſhip clear of the diſorder; but in a very few weeks it began to appear among thoſe ſeventy. About fifty of them were inoculated the ſecond time; the others had the diſeaſe in the natural way: an Harmattan came on, and they all recovered, except one girl, who had an ugly ulcer on the inoculated part, and died ſome time afterwards of a locked jaw. The great ſalubrity, and the power of checking epidemics, are ſuch extraordinary properties of the Harmattan, that I deſired Mr. NORRIS, on his next voyage to the Coaſt, to aſcertain theſe points by further inquiries.

inquiries. "I have not much new," ſays Mr. NORRIS, "on "theſe points, ſave the general teſtimony of the natives in con- "firmation of what I have already communicated; and that I "had been very ill myſelf for nine days with a remittent fever "this voyage, of which I recovered immediately upon the Har- "mattan beginning to blow; whether from the medicines "which I had taken, or from the alteration in the ſtate of the "atmoſphere, I pretend not to determine. I now learned, for "the firſt time, that the Harmattan is noted for contributing "much to the cure of ulcers, as well as cutaneous eruptions." Mr. NORRIS is ſorry to be obliged to diſſent from ſo reſpectable an authority as that of Dr. LIND, who ſpeaks of the Harmattan as "fatal and malignant; that its noxious vapours are deſtruc- "tive to Blacks as well as Whites; and that the mortality "which it occaſions is in proportion to the denſity and duration "of the fog." The baneful effects here pointed out proceed from the periodical rains which fall in March, April, &c. and which are uſhered in by the Tornadoes, or ſtrong guſts of wind from the N.E. and E.N.E. accompanied with violent thunder and lightning, and very heavy ſhowers. The earth drenched by theſe ſhowers, and acted upon with an intenſe ſolar heat as ſoon as the ſtorm is over, ſends forth ſuch noiſome vapours as ſtrike the noſtrils with a moſt offenſive ſtench, and occaſion bilious vomitings, fluxes, and putrid fevers. Beſides theſe va- pours, which are annual, there appears to be a collection of ſtill more peſtiferous matter, confined for a longer time, and iſſuing from the earth after an interval of five, ſix, or ſeven years. "The periods," ſays Mr. NORRIS, "which I remem- "ber to have been thus marked, were in 1756, when Governor "MELVILL and moſt of the gentlemen and ſoldiers at Cape "Coaſt, died; in 1763, 1769, and 1775. The mortality

"in

"in ſome of theſe years, for they were not all equally fatal, "was ſo great that, as Dr. LIND ſays, the living were ſcarce "ſufficient to remove and bury the dead."

It is to be obſerved, that there may be inſtances in which the Harmattan comes loaded with the effluvia of a putrid marſh; and if there are any ſuch ſituations, the nature of the wind may be ſo changed as to become even noxious.

Another inquiry which I deſired Mr. NORRIS to make reſpected the ſource of the Harmattan, and the nature of the ſoil over which it blows. It appears that, except a few rivers and ſome lakes, the country about and beyond Whydah is covered for four hundred miles back with verdure, open plains of graſs, clumps of trees, and ſome woods of no conſiderable extent. The ſurface is ſandy, and below that a rich reddiſh earth; it riſes with a gentle aſcent for one hundred and fifty miles from the ſea before there is the appearance of an hill, without affording a ſtone of the ſize of a walnut. Beyond theſe hills there is no account of any great ranges of mountains.

With reſpect to the origin of this wind, Mr. NORRIS ſays, "the Harmattan, according to Dr. LIND, ariſes from the con-"flux of ſeveral rivers about Benin; but when I was on a "viſit to the King of Dahomey, one hundred and twenty "miles North, or inland from the Fort at Whydah, I there "felt the Harmattan blowing from the N.E. ſtronger than I "have at any other time, though Benin then bore from me "S.E."

On this head Mr. NORRIS makes the following conjecture: "The interſection of three lines; *viz.* an eaſt line drawn from "Cape Verd, a north-eaſt one from the centre of the Gold "Coaſt, and a north line from Cape Lopez, would, I think, "point out a probable ſource of this extraordinary wind."

Three

Three lines, drawn according to the direction of Mr. NORRIS, towards the points of the compass from which the Harmattan blows on Cape Verd, the Gold Coast, and Cape Lopez, converge I find to a part of Africa about the 15th degree of N. latitude, and the 25th degree of E. longitude, which I also find to be that part of Africa where, according to PTOLEMY, the mountains of Caphas are situated. From these mountains, according to the same authority, the river Daradus arose, supposed by some to be now the river Senegal.

It may be conjectured, that the disagreeable Levant wind of the Mediterranean proceeds from the same part of the Continent of Africa; for it prevails during the same season of the year, and may derive its qualities from the surface over which it passes.

The last article of information with which I have been favoured by Mr. NORRIS, is an account of the manner in which the Fantee nation divide their year.

Aherramantah, from the 1st of December to the middle of February, about 10 weeks.

Quakorah, a wind up the coast, from S.S.W. to S.S.E. from the middle of February to the first week in March, about 3 weeks.

Pempina, or Tornado season, part of March, all April, and the greatest part of May, about 12 weeks.

Abrenama, or the old man's and woman's children, that is, the Pleiades, the rainy season, the latter end of May, all June, and to about the 20th of July, 8 weeks.

Atukogan, or five stars, that is, Orion, high wind and squally, the rains very heavy, to the middle of August, 3 weeks.

Worrobakorow,

Worrobakorou, or one ſtar, the ceaſing of the rains, about 3 weeks.

Mawurrah, the name of a certain ſtar; cloſe, foggy weather and no breeze, the firſt three weeks in September.

Boutch, no land breeze in this ſeaſon, the wind blows freſh down the Coaſt, about ſix weeks.

Autiophi, or the Croziers; Tornadoes and ſoutherly wind, with ſome rain, generally called the latter rains, about four weeks, to the beginning of December, when the Aherramantah ſeaſon again commences.

V. *Eſſay on a new Method of applying the Screw.* By Mr. William Hunter, *Surgeon; communicated by Lieutenant General* Melville, *F. R. S.*

Read December 21, 1780.

I HAVE ſome time ago been led to think, that the ſcrew, which of all the mechanical powers is the moſt commonly employed in performing motions which require great accuracy, might be applied in a manner which would better anſwer many intentions than that commonly uſed. The plan is ſomewhat ſimilar to NONIUS's diviſion of the circle; but before I explain myſelf farther it may be proper to lay down a few general rules on which we may found a compariſon.

The perfection of any machine conſiſts in accompliſhing the end propoſed in a manner the moſt effectual, the moſt expeditious, and the leaſt cumberſome poſſible. In order to attain this end the following things are required.

1. That the ſtrength of the ſeveral parts of the engine be ſo adjuſted to the force they are intended to exert, as that they ſhall not break under the weight they ought to counteract, nor yet encumber the motion by a greater quantity of matter than is neceſſary to give them a proper degree of ſtrength.

2. That the increaſe of power, by means of the machine, be ſo regulated, that while the force we can exert is thereby rendered adequate to the effect, it may not be retarded in procuring it more than is abſolutely neceſſary.

3. That

3. That the machine be as ſimple as is conſiſtent with other conditions.

4. That it be as portable and as little troubleſome in the application as poſſible.

5. That the contrivance be ſuch that the moving power may be applied in ſuch a way as to act to the greateſt advantage; and that the motion ultimately produced may have that direction and velocity which is moſt adapted to the execution of the deſign propoſed by the whole.

6. Of two machines, equal in other reſpects, that deſerves the preference in which the friction leaſt diminiſhes the effect propoſed by the whole.

It will eaſily appear, that ſome of theſe conditions, if carried to an extreme, will be inconſiſtent with ſome of the others. Here the proper medium conſiſts in adapting them to each other in ſuch a manner, as that the reſult of the advantages of both may be the greateſt, and that of the defects the leaſt, that is poſſible.

The following method of applying the ſcrew, I think, may in certain caſes be attended with ſome of theſe advantages to a greater degree than by thoſe commonly practiſed.

Let AB (fig. 1.) be a plate of metal in which the ſcrew CD plays, having a threads in an inch equal to a. Within the ſcrew CD there is a female ſcrew, by which is received the ſmaller ſcrew DE of $a+1$ threads in an inch. This ſcrew is retained from moving round along with the ſcrew CD by means of the apparatus at AFGB.

Now, if the handle CKL be turned a times round the ſcrew, CD will advance upwards an inch, and if we ſuppoſe the ſcrew DE to move round along with CD, the point E will alſo advance an inch. If we now turn the ſcrew DE a times backwards, the

point E will move downwards $\frac{a}{a+1}$ of an inch, and the refult of both motions will be to lift the point E upward $(1-\frac{a}{a+1}=)$ $\frac{1}{a+1}$ of an inch. But if, while the ſcrew CD is turned a times round, DE be kept from moving, the effect will be the ſame as if it had moved a times round with CD and been a times turned back, that is, it will advance $\frac{1}{a+1}$ of an inch. At one turn therefore of the handle CKL it will move upwards $(\frac{1}{a+1}\times\frac{1}{a}=)$ $\frac{1}{a^2+a}$ of an inch. If then we ſuppoſe the handle CKL to be b inches long, the power gained by the machine will be as $a^2+a\times 6{,}2832\,b$ to unity.

To illuſtrate this by a particular example, let the ſcrew CD have 10 threads in an inch, and DE 11: then, while the handle CKL is turned 10 times round, the point D will riſe one inch above its former ſituation. But at 10 turns it can only paſs over 10 threads of the ſcrew MB, and conſequently it will advance upon that ſcrew $\frac{1}{11}$ths of an inch. The point E therefore muſt riſe $\frac{1}{11}$th of an inch, that the point D may have room to riſe a complete inch above its former place: therefore, at one turn of the handle, the point E will riſe $\frac{1}{110}$th of an inch; and if the handle be ſuppoſed half a foot long, the power, to produce an equilibrium, muſt be to the weight as 1 to $110\times 6{,}2832\times 6=4146{,}912$, which is the very number expreſſed by the general theorem, *viz.* $a^2+a\times 6{,}2832\,b$, calling $a=10$ and $b=6$.

Now let us compare, according to the rules before laid down, this method of uſing the ſcrew with the common one. And, firſt, in order to have the ſame power by means of the common ſcrew that is exerted by this machine, it muſt have a number of

threads

threads in an inch equal to $a' + a$, which would render it too weak to resist any considerable violence. For example, if DC have five threads in an inch, and DE six, and if the handle CKL is a foot in length, the power gained by the engine will be nearly as $(\overline{a' + a} \times 6b =)$ 2160 to 1; whereas, to have the same force by means of the common screw, it must have 30 threads in an inch, and so must yield under a resistance which the other screw would overcome without any difficulty. Upon this principle, the screw may be applied with advantage in presses of different kinds, by fixing one of the plates of the press to the end of the screw at E.

As to the second requisite, both methods may be equally adapted to it; yet other circumstances will determine us to apply the common screw where a small increase of power is necessary, and the present contrivance, when we stand in need of a greater.

This will follow from the third rule, as in the method now proposed a double number of screws is required, which makes the structure more complicated, occasions more expence, and requires a greater accuracy of construction, since, unless this is attended to, the machine will not move.

However, the machine may, in some cases, answer the fourth intention better than the common one, as the power gained by the additional screw enables us to shorten the handle which will tend to make the whole more portable.

The power is here applied in the same direction as in the common screw, so that both equally answer the first part of the fifth rule; but as to the last, the motion *ultimately* produced, it will depend on particular circumstances which of them is most fit for use in any case. Thus, if the screw DE be intended to carry an index which must turn round at the same time that it rises upwards, the common screw is preferable; for although I

can

can ſee a method by which the machine before deſcribed may be made to anſwer this purpoſe, I am almoſt afraid to propoſe it. I mean, that within the ſcrew DE another ſtill ſmaller ſhould be made to play, and be connected with the ſcrew CD, ſo as to move round along with it. It muſt have a^2+a+1 threads in an inch, and they muſt be in the contrary direction to thoſe of CD, ſo that when they are both turned together, and CD moves upwards, this other one may move downwards. At one turn of the handle this will move upwards $\frac{1}{a^2+a} \times \frac{1}{a^2+a+1} = \frac{1}{a^4+2a^3+2a^2+a}$ of an inch, and at the ſame time will move round in a circular direction. For example, let CD have 5 threads ($=a$) in an inch, DE 6 ($=a1$), and a third ſcrew within DE, but connected with CD ſo as to partake of its motion, 31 ($=a^2+a+1$). At one turn of the handle, this ſcrew will riſe upwards $\frac{1}{5} \times \frac{1}{6} \times \frac{1}{31} = \frac{1}{930}$ of an inch; but this appears too complicated for uſe, and the leaſt inaccuracy in the conſtruction would hinder it from moving.

But, on the other hand, if while the point E riſes it is of conſequence that it be kept from going round, the machine under conſideration will beſt anſwer this purpoſe. On this principle it may be uſeful in ſeveral reſpects: for inſtance, let A (fig. 2.) repreſent a magnifying lens, and let it be moveable upon the ſcrew BC of 16 threads in an inch, which turns within the larger ſcrew CD of 15 threads in an inch, and that again moves within the plate EF in the end of the cylinder GF*. To uſe the inſtrument, fix the object to be magnified upon the pin GI, and then turn the lens A upon the ſcrew BC, till it be

* The ſcrew BC is reſtrained from moving along with CD by the ſmall pillar HK, which ſlides backwards and forwards in a groove in the cylinder GF.

nearly

nearly at the proper distance from the pin, and opposite to it. You may then adjust the distance more accurately by turning the screw DC, at each turn of which the lens will recede from, or approach to, the pin $\frac{1}{100}$th of an inch. This it will do and not turn aside, but still remain opposite to the pin LG. A double microscope might be fitted on in the place of the lens A. The whole instrument may be furnished with a handle, as at M; or, if larger, it may have three feet to stand on a table.

On the last principle it must be owned, the common screw has the advantage, as two screws will produce more friction than one; and, besides, in the compound engine there is an additional friction from the piece FG (fig. 1.) upon the pillars between which it moves.

Another case in which this machine may be employed is in the micrometer. Thus, let the screw AB (fig. 3.) of 50 threads in an inch be turned round by the index C, which moves upon the graduated circle ECD in the direction CD. Within the screw AB is the smaller one AF of 51 threads in an inch, retained from moving round by the bar GFH. The piece AF is continued to K, where it forms a fine point. To use the instrument, let it be adjusted to the telescope or microscope by which you are to view a star, or some small object, and let the point K appear just to touch one edge of the object. Then turn the index C, and the point K will advance upwards till it appears to cover the other edge of the object, and thus you can determine its size. The point K will advance at each complete turn of the index $\frac{1}{2500}$ of an inch; and if the circle be divided into 80 equal parts, one of which, if it is an inch in diameter, will be very observable, while the index moves over one of these, the point K will advance $\frac{1}{200000}$ of an inch.

Thus, for example, ſuppoſe I am to meaſure the diameter of a nervous fibre in the medullary ſubſtance of the brain, I make the point K appear cloſe to one edge, and turn the index till the ſame point paſs over the fibre, and appear to touch the other edge: I then look on the graduated circle ECD, and perceive that the index c has paſſed over, ſuppoſe, 23,2 diviſions. Hence I conclude the diameter of the fibre to be $23{,}2 \times \frac{1}{10000} = \frac{1}{4310}$ of an inch, which is nearly the ſize as found by the accurate obſervations of Dr. MONRO. There ſhould be a NONIUS's ſcale on the index which will meaſure to one tenth of a diviſion.

As the index c muſt continue cloſe to the plate ECD, while at the ſame time it turns round the ſcrew AB, which is continually riſing, it muſt be made as in fig. 4. where *a*, *b*, are two ſmall pieces which play in a groove in the ſcrew AB (fig. 3.) while the groove CD (fig. 4.) in the index is filled up by a protuberance of the plate ECD (fig. 3.); the piece below the groove *cd* (fig. 4.) being ſunk into that plate. The whole machinery may be incloſed in a cylinder of braſs reaching from B to L (fig. 3.), ſo that the point of the ſcrew KL may be without it, and the ſides of the cylinder may be open at ECD.

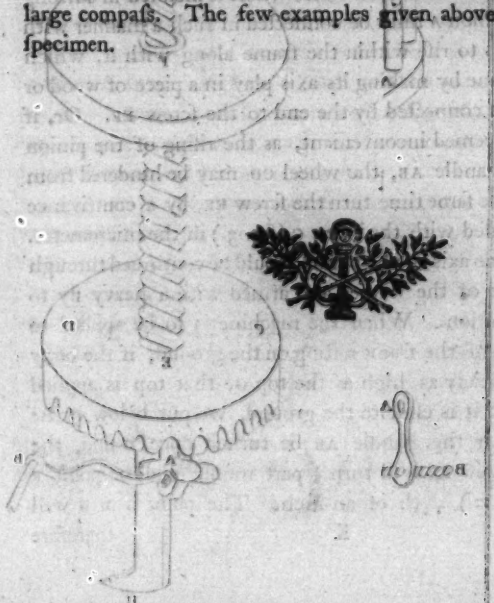
It is farther to be obſerved, that what has been ſaid goes on the ſuppoſition that the point K, in the micrometer, is equally magnified with the object we are to meaſure. But, if this point be placed in the focus of the eye-glaſs of a double microſcope; when it moves it will paſs over, not the object itſelf, but its image, magnified by the object-glaſs. In this caſe, if the object-glaſs magnify the diameter 10 times, while the index paſſes over one diviſion, the point K will paſs over the image of an object, the diameter of which is $\frac{1}{10000}$ of an inch. As in this mode of application the point K muſt fall between the object

object and eye-glass, the screws may be contained within the *fulcrum* by which the microscope is supported.

The machine (fig. 1.) may be applied as a jack to raise great weights a little way from the ground, by substituting two cross hand-spikes for the handle CKL; or a vertical handle may be employed in the following manner. Let A (fig. 5.) be a pinion turned by the handle AB, which we suppose a foot in length. Let the pinion A have 4 teeth, and move the wheel CD of 16 teeth. The screw EF of 4 threads in an inch is fixed in this wheel, and turns round along with it. Within it plays the screw FG of 5 threads in an inch, and which we suppose prevented from following the motion of EF: it terminates in such a shoulder as that represented at G, and being continued to H ends in a foot as in the figure. The whole is inclosed in a strong frame. The pinion A must be connected in such a manner with the wheel CD as to rise within the frame along with it, which may easily be done by making its axis play in a piece of wood or metal, which is connected by the end to the screw EF. Or, if this should be deemed inconvenient, as the rising of the pinion must raise the handle AB, the wheel CD may be hindered from rising, and at the same time turn the screw EF, by a contrivance similar to that used with the index C (fig. 3.) in the micrometer. In either case, the axis of the pinion should be continued through the opposite side of the frame, and armed with a heavy fly to regulate the motion. When the machine is to be applied to use, the bottom of the frame resting on the ground, if the body to be lifted is already as high as the top G, that top is applied below it; but if it is close to the ground, we put below it the foot H; then, if the handle AB be turned once round, the wheel CD and screw EF will turn $\frac{1}{4}$ part round, and the point F will rise ($\frac{1}{4} \times \frac{1}{4} =$) $\frac{1}{16}$th of an inch. The point G or H will

therefore be lifted upwards ($\frac{1}{720} \times \frac{1}{1} =$) $\frac{1}{720}$th of an inch. But the end B of the handle AB has described above six feet; therefore the velocity of the point G is to that of the point B as one to (72 × 80 =) 5760. Therefore, if we suppose a man to act at the handle with a force equal to 30 lbs. he may keep in equilibrio a weight of 172800 lbs. But a subduction of perhaps more than one half of this must be made, that he may raise the weight, as the friction of the engine will be considerable. Suppose it to be two-thirds, the effect still remains equal to 57600 lbs. or 25 tons 14 cwts. and 32 lbs.

It will easily appear, that this method of applying the screw may have a place in many other engines, particularly where great accuracy is required; or we want a motion to be performed with great power, while at the same time it need not have any large compass. The few examples given above may serve as a specimen.



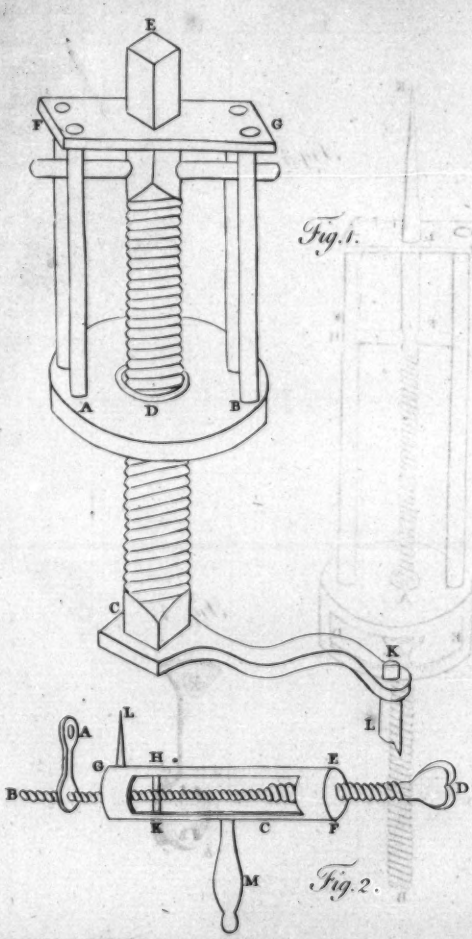


Fig. 1.

Fig. 2.

Fig. 3.

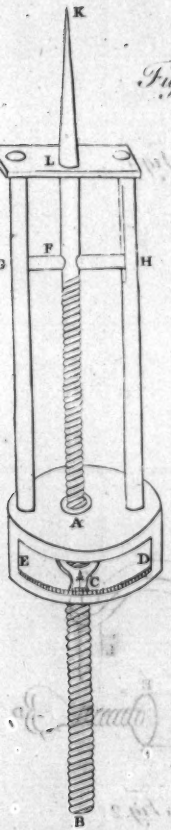
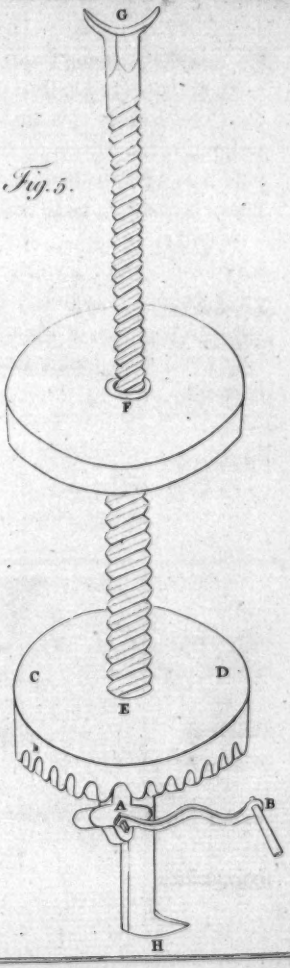


Fig. 4.

Fig. 5.



BASIRE sc.

VI. *An Account of the* Turkey. *By* Thomas Pennant, *Eſq. F. R. S.; communicated by* Joſeph Banks, *Eſq. P. R. S.*

Read December 21, 1781.

TURKEY. BILL convex, ſhort and ſtrong,

HEAD and neck covered with a naked tuberoſe fleſh, with a long fleſhy appendage hanging from the baſe of the upper mandible.

ON the breaſt a long tuft of coarſe black hairs.

Wild Turkey. JOSSELYN's Voy. 99. Rarities 8. CLAYTON's Virgin: Phil. Tranſ. abridged, III. 590. LAWSON, 149. CATESBY Topp. XLIV.

Le coq d'Inde, BELON 248.

Gallo-pavo, GESNER Av. 481. Icon. 56.

Gallo-pavo, ALDROV. Av. II. 18.

Gallo-pavo, the Turkey, A. 3. Gallo-pavo ſylveſtris Novæ Angliæ, a New England wild Turkey, RAII Synopſis Avium 51.

Meleagris Gallo-pavo. M. capite caruncula frontali gularique, maris pectore barbato, LIN. Syſt. 268.

Le Dindon de BUFFON III. BRISSON. I. 158. tab. XVI. Pl. Enl. 97.

Deſcription. T. with the characters deſcribed in the definition of the genus. The plumage, dark gloſſed with variable copper colour, and green. Coverts of the wings and the quill feathers barred with

Tail. black and white. Tail conſiſts of two orders. The upper or ſhorter very elegant, the ground colour a bright bay; the middle feather marked with numerous bars of ſhining black and green. The greateſt part of the exterior feathers of the ſame ground with the others marked with three broad bands of mallard green, placed remote from each other. The two next are coloured like thoſe of the middle; but the end is plain and croſſed with a ſingle bar, like the exterior.

The longer or lower order are of a ruſty white colour, mottled with black; and croſſed with numerous narrow-waved lines of the ſame colour, and near the end with a broad band.

Wild Turkies preſerve a ſameneſs of colouring; the tame, as uſual with domeſtic animals, vary. It is needleſs to point out the differences in ſo well known a bird: the black approaches neareſt to the original ſtock. This variety I have ſeen nearly in a ſtate of nature in Richmond and other parks. A moſt beautiful kind has of late been introduced

White variety. into England of a ſnowy whiteneſs, finely contraſting with its red head. Theſe, I think, came out of Holland, probably bred from an accidental white pair; and from them preſerved pure from any dark or variegated birds.

Size.

Size. The ſizes of the wild Turkies have been differently repreſented. Some writers aſſert, that there have been inſtances of their weighing ſixty pounds; but I find none who, ſpeaking from their own knowlege, can prove their weight to be above forty. JOSSELYN ſays, that he has eaten part of a cock, which after it was plucked, and the entrails taken out, weighed thirty *. LAWSON, whoſe authority is unqueſtionable, ſaw half a Turkey ſerve eight hungry men for two meals †; and ſays, that he had ſeen others which he believed weighed forty pounds. CATESBY tells us, that out of the many hundreds which he had handled §, very few exceeded thirty pounds; each of theſe ſpeak of their being double that ſize merely from the reports of others.

Manners. The manners of theſe birds are as ſingular as their figure. Their attitudes in the ſeaſon of courtſhip are very ſtriking. The males fling their heads and neck backwards, briſtle up their feathers, drop their wings to the ground, ſtrut and pace moſt ridiculouſly; wheel round the females with their wings ruſtling along the earth, at the ſame time emitting a ſtrange ſound through their noſtrils

Notes. not unlike the *Grurr* of a great ſpinning wheel. On being interrupted they fly into great rages, and change their notes into a loud and guttural gobble,

* New England Rarities, p. 8.

† Hiſtory of Carolina, p. 149. and 27.

§ App. XLIV. The greateſt certain weight is given by Mr. CLAYTON, who ſaw one that reached 38 lbs. Phil. Tranſ.

and

and then return to dalliance. The ſound of the female is plaintive and melancholy.

Iraſcible. The paſſions of the males are very ſtrongly expreſſed by the change of colours in the fleſhy ſubſtance of the head and neck, which alters to red, white, blue, and yellowiſh, as they happen to be affected. The ſight of any thing red excites their choler greatly.

Polygamous. They are polygamous, one cock ſerving many hens. They lay in the ſpring, and produce a great number of eggs. They will perſiſt in laying for a great while. They retire to ſome obſcure place to ſit, the cock through rage at the loſs of its mate being very apt to break the eggs. The females are very affectionate to their young, and make great moan on the loſs of them. They ſit on their eggs with ſuch perſeverance, that if they are not taken away when addle, the hens will almoſt periſh with hunger before they will quit the neſt.

Turkies greatly delight in the ſeeds of nettles; but thoſe of the purple-fox glove prove fatal to them *.

Turkies are very ſtupid birds, quarrelſome, and cowardly. It is diverting to ſee a whole flock attack the common cock, who will, for a long time, keep a great number at bay.

Swift. They are very ſwift runners in the tame as well

Perch high. as the wild ſtate: they are but indifferent flyers. They love to perch on trees, and gain the height

* DE BUFFON.

they wish by rising from bough to bough. In a wild state they get to the very summit of the loftiest trees, even so high as to be beyond the reach of the musquet *.

Gregarious. In the state of nature they go in flocks even of five hundred †, feed much on the small red acorns, and grow so fat in *March* that they cannot fly more than three or four hundred yards, and are soon ran down by a horseman. In the unfrequented parts bordering on the *Mississipi*, they are so tame as to be shot with even a pistol ‡.

Haunts. They frequent the great swamps § of their native country, and leave them at sun-rising to repair to the dry woods in search of acorns and berries; and before sun-set retire to the swamps to roost.

The flesh of the wild Turkey is said to be superior in goodness to the tame, but redder. Eggs of the former have been taken from the nest, and hatched under tame Turkies. The young will still prove wild, perch separate, yet mix and breed together in the season. The Indians sometimes use the breed produced from the wild as decoy birds to seduce those in a state of nature within their reach ‖.

* LAWSON, 45.

† ADAIR's Amer. 360.

‡ LAWSON, 149.

§ It is in the swamps that the loftiest and most bulky trees are. The wet with which they are environed makes them a secure retreat.

‖ LAWSON, 149.

Wild

Wild Turkies are now grown moſt exceſſively rare in the inhabited parts of *America*, and are only found in numbers in the diſtant and moſt unfrequented ſpots.

The Indians make a moſt elegant cloathing of the feathers. They twiſt the inner webs into a ſtrong double thread of hemp, or inner bark of the mulberry tree, and work it like matting; it appears very rich and gloſſy, and as fine as a ſilk ſhag *. They alſo make fans of the tail; and the French of *Louiſiana* were wont to make umbrellas by the junction of four of the tails †.

When diſturbed, they do not take wing, but run out of ſight. It is uſual to chaſe them with dogs, when they will fly and perch on the next tree. They are ſo ſtupid or ſo inſenſible of danger, as not to fly on being ſhot at; but the ſurvivors remain unmoved at the death of their companions ‡.

Place. Turkies are natives only of *America*, or the New World, and of courſe unknown to the ancients. Since both theſe poſitions have been denied by ſome of the moſt eminent naturaliſts of the ſixteenth century, I beg leave to lay open, in as few words as poſſible, the cauſe of their error.

Miſtaken by BELON. BELON §, the earlieſt of thoſe writers who are of opinion that theſe birds were natives of the

* LAWSON, 18. ADAIR, 423.
† DU PRATZ, II. 85.
‡ DU PRATZ, 224.
§ Hiſt. des Oys. 248.

old world, founds his notion on the deſcription of the Guinea fowl, the Meleagrides of STRABO, ATHENÆUS, PLINY, and others of the ancients. I reſt the refutation on the excellent account given by ATHENÆUS, taken from CLYTUS MILESIUS, a diſciple of ARISTOTLE, which can ſuit no other than that fowl. "They want," ſays he, "natural affection towards their young; their head "is naked, and on the top is a hard round body "like a peg or nail: from their cheeks hangs "a red piece of fleſh like a beard. It has no "wattles like the common poultry. The feathers are black, ſpotted with white. They have "no ſpurs; and both ſexes are ſo like as not to be "diſtinguiſhed by the ſight." VARRO * and PLINY † take notice of the ſpotted plumage and the gibbous ſubſtance on the head. ATHENÆUS is more minute, and contradicts every character of the Turkey, whoſe females are remarkable for their natural affection, and differ materially in form from the males, whoſe heads are deſtitute of the callous ſubſtance and whoſe heels (in the males) are armed with ſpurs.

ALDROVANDUS. ALDROVANDUS, who died in 1605, draws his arguments from the ſame ſource as BELON; I therefore paſs him by, and take notice of the greateſt of our naturaliſts GESNER ‡, who falls into a miſtake of another kind, and wiſhes the

GESNER.

* Lib. III. c. 9.
† Lib. X. c. 26.
‡ Av. 481.

Turkey to be thought a native of India. He quotes ÆLIAN for that purpoſe, who tells us, "That in India are very large poultry not with "combs, but with various coloured creſts inter- "woven like flowers, with broad tails neither "bending nor diſplayed in a circular form, which "they draw along the ground as peacocks do "when they do not erect them; and that the "feathers are partly of a gold colour, partly "blue, and of an emerald colour" *.

This in all probability was the ſame bird with the Peacock Pheaſant of *Mr.* EDWARDS, *Le Paon de Tibet* of M. BRISSON, and the *Pavo bicalcaratus* of LINNÆUS. I have ſeen this bird living. It has a creſt, but not ſo conſpicuous as that deſcribed by ÆLIAN; but it has thoſe ſtriking colours in form of eyes, neither does it erect its tail like the Peacock †, but trails it like the Pheaſant. The *Catreus* of STRABO ‡ ſeems to be the ſame bird. He deſcribes it as uncommonly beautiful and ſpotted, and very like a Peacock. The former author § gives a more minute account of this ſpecies, and under the ſame name. He borrows it from CLITARCHUS, an attendant of ALEXANDER the Great in all his conqueſts. It is evident from his deſcription, that it was of this kind; and it is likewiſe probable, that it was the ſame with his large Indian

* De Anim. lib. XVI. c. 2.

† Edw. II. 67.

‡ Lib. XV. p. 1046

§ De Anim. lib. XVII. c. 23.

poultry

poultry before cited. He celebrates it alſo for its fine note; but allowance muſt be made for the credulity of ÆLIAN. The *Gatreus*, or Peacock Pheaſant, is a native of Tibet, and in all probability of the north of India, where CLITARCHUS might have obſerved it; for the march of ALEXANDER was through that part which borders on Tibet, and is now known by the name of *Penj-ab* or five rivers.

Not natives of Europe;

I ſhall now collect from authors the ſeveral parts of the world where Turkies are unknown in the ſtate of nature. Europe has no ſhare in the queſtion; it being generally agreed that they are exotic in reſpect to that continent.

nor of Aſia;

Neither are they found in any part of Aſia Minor, or the Aſiatic Turky, notwithſtanding ignorance of their true origin firſt cauſed them to be named from that empire. About Aleppo, capital of Syria, they are only met with, domeſticated like other poultry *. In Armenia they are unknown, as well as in Perſia; having been brought from Venice by ſome Armenian merchants into that empire †, where they are ſtill ſo ſcarce as to be preſerved among other rare fowl in the royal menagery ‡.

DU HALDE acquaints us, that they are not natives of China; but were introduced there from other

* RUSSEL, 63.

† TAVERNIER, 146.

‡ BELL's Travels, I. 128.

countries. He errs from miſinformation in ſaying that they are common in India.

I will not quote GEMELLI CARERI, to prove that they are not found in the Philippine Iſlands, becauſe that gentleman with his pen travelled round the world in his eaſy chair, during a very long indiſpoſition and confinement * in his native country.

But DAMPIER bears witneſs that none are found in Mindanao ‡.

nor Africa; The hot climate of Africa barely ſuffers theſe birds to exiſt in that vaſt continent, except under the care of mankind. Very few are found in Guinea, except in the hands of the Europeans, the negroes declining to breed any on account of the great heats §. PROSPER ALPINUS ſatisfies us, they are not found either in Nubia or in Egypt. He deſcribes the Meleagrides of the ancients, and only proves that the Guinea hens were brought out of Nubia, and ſold at a great price at Cairo ‖; but is totally ſilent about the Turkey of the moderns.

Let me in this place obſerve, that the Guinea hens have long been imported into Britain. They were cultivated in our farm-yards; for I diſcover in 1277, in the Grainge of Clifton, in the

* Sir JAMES PORTER's Obſ. Turkey, I. 1. 321.

‡ BARBOT in CHURCHILL's Coll. V. 29.

§ BOSMAN, 229.

‖ Hiſt. Nat. Ægypti, I. 201.

pariſh of Ambroſden in Buckinghamſhire, among other articles, ſix *Mutilones* and ſix *Africanæ fœminæ* *, for this fowl was familiarly known by the names of Afra Avis and Gallina Africana and Numida. It was introduced into Italy from Africa, and from Rome into our country. They were neglected here by reaſon of their tenderneſs and difficulty of rearing. We do not find them in the bills of fare of our ancient feaſts †; neither do we find the Turkey: which laſt argument amounts to almoſt a certainty, that ſuch a hardy and princely bird had not found its way to us. The other likewiſe was then known by its claſſical name; for that judicious writer Doctor CAIUS deſcribes, in the beginning of the reign of ELIZABETH, the Guinea fowl, for the benefit of his friend GESNER, under the name of Meleagris, beſtowed on it by ARISTOTLE ‡.

Having denied, on the very beſt authorities, that the Turkey ever exiſted as a native of the old world, I muſt now bring my proofs of its being only a native of the new, and of the period in which it firſt made its appearance in Europe.

but of America, The firſt preciſe deſcription of theſe birds is given by OVIEDO, who in 1525 drew up a ſummary of his greater work, the Hiſtory of the

* KENNET's Parochial Antiq. 287.

† Neither in that of GEORGE NEVIL nor among the delicacies mentioned in the Northumberland houſhold book begun in the beginning of the reign of HENRY VIII.

‡ CAII Opuſc. 13. Hiſt. An. lib. VI, c. 2.

Indies,

Indies, for the uſe of his monarch CHARLES V.
the iſlands, This learned man had viſited the Weſt Indies and its iſlands in perſon, and payed particular regard to the natural hiſtory. It appears from him, that the Turkey was in his days an inhabitant of the greater iſlands, and of the main-land. He ſpeaks of them as Peacocks; for being a new bird to him, he adopts that name from the reſemblance he thought they bore to the former. "But," ſays he, "the neck is bare of feathers, "but covered with a ſkin which they change "after their phantaſie into diverſe colours. They "have * a horn as it were on their front, and "haires on the breaſt †." He deſcribes other birds which he alſo calls Peacocks. They are of the gallinaceous genus, and known by the name of Curaſſao birds, the male of which is black, the female ferruginous.

The next who ſpeaks of them as natives of the main-land of the warmer parts of America, is FRANCISCO FERNANDEZ, ſent there by PHILIP II. to whom he was phyſician. This naturaliſt
Mexico, obſerved them in Mexico. We find by him, that the Indian name of the male was Huexolotl, of the female Cihuatotolin. He gives them the title of Gallus Indicus and Gallo Pavo. The Indians, as well as Spaniards, domeſticated theſe uſeful birds. He ſpeaks of the ſize by compariſon, ſaying, that the wild were twice the magnitude of

* In the Spaniſh Peçon corto.

† In PURCHAS, III. 995.

I th

the tame; and that they were ſhot with arrows or guns*. I cannot learn the time when FERNANDEZ wrote. It muſt be between the years 1555 and 1598, the period of PHILIP's reign.

Darien. PEDRO DE CIESA mentions Turkies on the Iſthmus of Darien†. LERY, a Portugueſe author, aſſerts, that they are found in Brazil, and gives them an Indian name ‡; but ſince I can diſcover no traces of them in that diligent and excellent naturaliſt MARCGRAVE, who reſided long in that country, I muſt deny my aſſent. But the former is confirmed by that able and honeſt navigator DAMPIER, who ſaw them frequently, as well wild as tame, in the province of Yucatan §, now reckoned part of the kingdom of Mexico.

Yucatan.

North America. In North America they were obſerved by the very firſt diſcoverers. When RENÉ DE LAUDONNIERE, patronized by Admiral COLIGNI, attempted to form a ſettlement near the place where Charleſtown now ſtands, he met with them on his firſt landing in 1564, and by his hiſtorian has repreſented them with great fidelity in the fifth plate of the recital of his voyage ||: from his time the witneſſes to their being natives of the continent are innumerable. They have been ſeen in flocks of hundreds in all parts from Louiſiana

* Hiſt. Av. Nov. Hiſp. 27.

† Seventeen Years Travels, 20.

‡ In DE LAET's Descr. des Indes, 491.

§ Voyages, vol. II. part II. p. 65. 85. 114.

|| DE BRY.

even

even to Canada; but at this time are extremely rare in a wild ſtate, except in the more diſtant parts, where they are ſtill found in vaſt abundance.

When firſt introduced into Europe.

It was from Mexico or Yucatan that they were firſt introduced into Europe; for it is certain, that they were imported into England as early as the year 1524, the 15th of HENRY VIII *.

We probably received them from Spain, with which we had great intercourſe till about that time. They were moſt ſucceſsfully cultivated in our kingdom from that period; inſomuch, that they grew common in every farm-yard, and became even a diſh in our rural feaſts by the year 1585; for we may certainly depend on the word of old TUSSER, in his Account of the Chriſtmas Huſbandlie Fare †.

Beefe, Mutton, and Porke, ſhred pies of the beſt,
Pig, Veale, Gooſe, and Capon, and Turkie well dreſt,
Cheeſe, Apples, and Nuts, jolie carols to heare,
As then in the countrie, is counted good cheare.

But at this very time they were ſo rare in France, that we are told, that the very firſt which was eaten in that kingdom appeared at the nuptial feaſt of CHARLES IX. in 1570 ‡.

* BAKER's Chr. ANDERSON's Diſt. Com. I. 354. HACKLUYT, II. 165. makes their introduction about the year 1532. BARNABY GOOGE, one of our early writers on Huſbandry, ſays, they were not ſeen here before 1530. He highly commends a Lady HALES of Kent, for her excellent management of theſe fowl, p. 166.

† Five Hundred Points of good Huſbandrie, p. 57.

‡ ANDERSON's Diſt. Comm. I. 410.

To

To this account I beg leave to lay before you the very extraordinary appearance on the thigh of a Turkey, bred in my poultry yard, and which was killed a few years ago for the table. The ſervant in plucking it was very unexpectedly wounded in the hand. On examination the cauſe appeared ſo ſingular, that the bird was brought to me. I diſcovered, that from the thigh-bone iſſued a ſhort upright proceſs, and to that grew a large and ſtrong toe, with a ſharp and crooked claw, exactly reſembling that of a rapacious bird.

VII. *Account of a* Nebula *in* Coma Berenices. *By* Edward Pigott, *Esq. In a Letter to* Nevil Maskelyne, *D. D. F. R. S. and Astronomer Royal.*

Read January 11, 1781.

REV. SIR,

Frampton-house, Glamorganshire, September 3, 1779.

AS my father generally addresses to you such papers as he communicates to the Royal Society, I beg the favour of you to acquaint that learned body, that, on the 23d of March, I discovered a nebula in the constellation of Coma Berenices, hitherto, I presume, unnoticed; at least not mentioned in M. DE LA LANDE's Astronomy, nor in M. MESSIER's ample Catalogue of nebulous Stars. I have observed it in an achromatic transit instrument, three feet long, and deduced its mean R. A. by comparing it to the following stars, having made the necessary corrections for aberration and nutation, the results are:

By δ Gemini	191	28	35
By γ Canis Majoris	191	28	41
By ϵ Virginis	191	28	45
By ν Virginis	191	28	36
By δ Leonis	191	28	34
Mean R. A. of the nebula for April 20, 1779,	191	28	38

Its

Its light being exceedingly weak, I could not see it in the two-feet telescope of our quadrant, so was obliged to determine its declination likewise by the transit instrument. This determination, however, I believe, may be depended upon to two minutes: hence its declination north is 22° 43′. The diameter of this nebula I judged to be about two minutes of a degree.

I am, &c.

E. PIGOTT.

VIII. *Double Stars discovered in* 1779; *at* Frampton-house, Glamorganshire. *By* Nathanael Pigott, *Esq. F. R. S. Foreign Member of the Academies of* Brussels *and* Caen, *and Correspondent of the Royal Academy of Sciences at* Paris; *communicated by* Nevil Maskelyne, *D. D. F. R. S. and Astrononomer Royal.*

Read January 11, 1781.

TO THE REV. NEVIL MASKELYNE.

REV. SIR, October 27, 1779.

INCLOSED are the determinations of the places of three double stars, which I discovered this summer; at least, I presume, they have not been observed before, because I do not find them inserted in Dr. BRADLEY's catalogue, published in the Nautical Almanac 1773, or in the *Connoissance des Tems*, no more than in other catalogues in my possession. γ Delphini, indeed, is in M. DE LA CAILLE's catalogue; but not as a double star. The instrument he used was not, probably, powerful enough for that purpose. In the two-feet telescope of my quadrant it appears only as a single star. These stars were observed by me in a three-feet achromatic telescope of a transit instrument, with an object-glass near two inches diameter. The R. A. are nicely determined by several observations, which always agree with each to a fraction of a second in time. The declinations

declinations were deduced from the difference of altitudes between the double ſtars and the known ſtars, to which they were compared, as ſhewn by the graduated ſemi-circle of the tranſit inſtrument, which, being divided to two minutes only, cannot be ſuppoſed to give any great preciſion: however, I believe, their declinations, hence deduced, to be correct to one minute, or one minute and a half.

In obſerving the double ſtar compared to ζ Pegaſi, I found it impoſſible to illuminate the wires of the tranſit inſtrument, without nearly obliterating the ſtar. This difficulty led me to a method, which, as it completely ſucceeded, may, under ſimilar circumſtances, poſſibly be of uſe to others. A perſon illuminating the wires very faintly, ſo that I could juſt perceive the double ſtar, at a ſignal totally withdrew the light: this ſignal I made when the double ſtar was nearly as far diſtant from the firſt wire as the five wires are diſtant from each other, which, in this caſe, was 13″ by the clock. I then counted the ſeconds, and did not fail to ſee the ſtar diſappear a ſecond or two within the time expected. On its diſappearing, I made a ſignal to write down; and then beginning to count again, did the ſame at each wire. I have ſince tried this method with other ſtars, and think they may be thus obſerved, even with greater preciſion than when the wires are illuminated. Hence the troubleſome buſineſs, well known to aſtronomers, of illuminating faint objects, may be removed.

The preceding ſtar of each double ſtar was obſerved on the firſt, third and fifth wires, and the following one on the ſecond and fourth wires; and thus their difference in R. A. in time, converted into parts of a great circle, obtained. Suppoſing the apparent R. A. and App. declinations of α Delphini, β Aquarii, and ζ Pegaſi, as here aſſumed, the places of theſe double ſtars were found to be as follows.

I beg

I beg you to communicate these observations to the Royal Society, and to receive my thanks for those I received in your letter of the 7th instant.

I am, &c.

N. PIGOTT.

September 5, 1779.

App. R. A.				App. declination.
307 21 5		α Delphini, 3d mag. -	15 8 53	N.
309 6 30		2d or brightest of γ Delphini 4.	15 20 40	N.
0	9½	diff. R. A. of the 2 stars in γ Delphini.		

Note, both the stars in γ Delphini have the same, or nearly the same, declination. The 1st is of the 6th, the 2d of the 4th mag.

September 19.

339 59 27 +		β Aquarii, 3d mag. -	6 31 34	S.
338 35 21		preceding double star, 5th mag.	7 40 34	S.
0	11	diff. R. A. between 1st and 2d of the double star.		

Note, the 1st seemed of the 5th, the 2d of the 7th mag. The 1st is perhaps 6″ or 8″ S. of the following one.

337 36 55 +		ζ Pegasi, 3d mag. -	9 41 24	N.
346 53 36½		double star, 8th, 9th mag -	3 59 17	N.

Note, both the stars of this double star have the same, or nearly the same, R. A.; their difference in declination is 15″ or perhaps 20″.

IX. *An Account of the* Ganges *and* Burrampooter *Rivers.* By James Rennell, *Esq. F. R. S.*; *communicated by* Joseph Banks, *Esq. P. R. S.*

Read January 25, 1781.

THE * Ganges and + Burrampooter Rivers, together with their numerous branches and adjuncts, interſect the country of Bengal in ſuch a variety of directions, as to form the moſt compleat and eaſy inland navigation that can be conceived. So equally and admirably diffuſed are thoſe natural canals, over a country that approaches nearly to a perfect plane, that, after excepting the lands contiguous to Burdwan, Birboom, &c. (which altogether do not conſtitute a ſixth part of Bengal) we may fairly pronounce, that every other part of the country has, even in the dry ſeaſon, ſome navigable ſtream within 25 miles at fartheſt, and more commonly within a third part of that diſtance.

It is ſuppoſed, that this inland navigation gives conſtant employment to 30,000 boatmen. Nor will it be wondered at, when it is known, that all the ſalt, and a large proportion of the

* The proper name of this river in the language of Hindooſtan (or Indoſtan) is Pudda or Padda. It is alſo named Burra-Gonga, or the Great River; and Gonga, the River, by way of eminence; and from this, doubtleſs, the European names of the river are derived.

+ The orthography of this word, as given here, is according to the common pronunciation in Bengal; but it is ſaid to be written in the Sanſcrit language, Brahma-pootar, which ſignifies the Son of Brahma.

food conſumed by ten millions of people are conveyed by water within the kingdom of Bengal and its dependencies. To theſe muſt be added, the tranſport of the commercial exports and imports, probably to the amount of two millions ſterling *per annum*; the interchange of manufactures and products throughout the whole country; the fiſheries; and the article of travelling *.

Theſe rivers, which a late ingenious gentleman aptly termed ſiſters and rivals (he might have ſaid *twin* ſiſters, from the contiguity of their ſprings), exactly reſemble each other in length of courſe; in bulk, until they approach the ſea; in the ſmoothneſs and colour of their waters; in the appearance of their borders and iſlands; and, finally, in the height to which their floods riſe with the periodical rains. Of the two, the Burrampooter is the largeſt; but the difference is not obvious to the eye. They are now well known to derive their ſources from the vaſt mountains of Thibet †; from whence they proceed in oppoſite directions; the Ganges ſeeking the plains of Hindooſtan (or Indoſtan) by the weſt; and the Burrampooter by the eaſt; both purſuing the early part of their courſe through rugged vallies and defiles, and ſeldom viſiting the habitations of men. The Ganges, after wandering about 750 miles through theſe mountainous regions, iſſues forth a deity to the ſuperſti-

* The embarkations made uſe of vary in bulk from 180 tons down to the ſize of a wherry. Thoſe from 30 to 50 tons are reckoned the moſt eligible for tranſporting merchandize.

† Theſe are amongſt the higheſt of the mountains of the old hemiſphere. I was not able to determine their height; but it may in ſome meaſure be gueſſed, by the circumſtance of their riſing conſiderably above the horizon, when viewed from the plains of Bengal, at the diſtance of 150 miles.

tions, yet gladdened, inhabitant of Hindooſtan *. From Hurdwar (or Hurdoar) in latitude 30°, where it goſhes through an opening in the mountains, it flows with a ſmooth navigable ſtream through delightful plains during the remainder of its courſe to the ſea (which is about 1350 miles) diffuſing plenty immediately by means of its living productions; and ſecondarily by enriching the adjacent lands, and affording an eaſy means of tranſport for the productions of its borders. In a military view, it opens a communication between the different poſts, and ſerves in the capacity of a *military way* through the country; renders unneceſſary the forming of magazines; and infinitely ſurpaſſes the celebrated inland navigation of North America, where the *carrying places* not only obſtruct the progreſs of an army, but enable the adverſary to determine his place and mode of attack with certainty.

In its courſe through the plains, it receives eleven rivers, ſome of which are equal to the Rhine, and none ſmaller than the

* The fabulous account of the origin of the Ganges (as communicated by my learned and ingenious friend C. W. BOUGHTON KOUSE, Eſq.) is, that it flows out of the foot of Beſchan * (from whence, ſay the Brahmins, it has its name Padda; that word ſignifying foot in the Sanſcrit language); and that in its courſe to the plains of Hindooſtan it paſſes through an immenſe rock ſhaped like a Cow's-head.

The allegory is highly expreſſive of the veneration which the Hindoos have for this famous ſtream; and no leſs ſo of their gratitude to the Author of Nature for beſtowing it: for it deſcribes the bleſſing as flowing purely from his bounty and goodneſs.

The rock before mentioned has, I believe, never been viſited by any European; and is even allowed by moſt of the natives to bear no reſemblance to the object from whence it is denominated. However, as the effects of ſuperſtition do often long ſurvive the illuſions that gave it birth, the rock or cavern ſtill preſerves the name of *Gowmooky*, or Cow's-head.

* Beſchan is the ſame with Viſhnou, the PRESERVING DEITY.

Thames, beſides as many others of leſſer note. It is owing to this vaſt influx of ſtreams, that the Ganges exceeds the Nile ſo greatly in point of magnitude, whilſt the latter exceeds it in length of courſe by one-third. Indeed, the Ganges is inferior in this laſt reſpect, to many of the northern rivers of Aſia; though I am inclined to think that it diſcharges as much or more water than any of them, becauſe thoſe rivers do not lie within the limits of the periodical rains *.

The bed of the Ganges is, as may be ſuppoſed, very unequal in point of width. From its firſt arrival in the plains at Hurd-

* The proportional lengths of courſe of ſome of the moſt noted rivers in the world are ſhewn nearly by the following numbers:

European Rivers.		
	Thames,	1
	Rhine,	5½
	Danube,	7
	Wolga,	9½
Aſiatic rivers.		
	Indus,	5½
	Euphrates,	8½
	Ganges,	9½
	Burrampooter,	9½
	Nou Kian, or Ava River,	9½
	Jenniſea,	10
	Oby,	10½
	Amoor,	11
	Lena,	11½
	Hoanho (of China),	13½
	Kian Keu (of ditto),	15½
African river.		
	Nile,	12½
American rivers.		
	Miſſiſipi,	8
	Amazons,	15½

war,

war, to the conflux of the Jumnah (the firſt river of note that joins it) its bed is generally from a mile to a mile and a quarter wide; and, compared with the latter part of its courſe, tolerably ſtraight. From hence, downward, its courſe becomes more winding, and its bed conſequently wider*, till, having alternately received the waters of the Gogra, Soane, and Gunduck, beſides many ſmaller ſtreams, its bed has attained its full width; although, during the remaining 600 miles of its courſe it receives many other principal ſtreams. Within this ſpace it is, in the narroweſt parts of its bed, half a mile wide, and in the wideſt, three miles; and that, in places where no iſlands intervene. The ſtream within this bed is always either increaſing or decreaſing, according to the ſeaſon. When at its loweſt (which happens in April) the principal channel varies from 400 yards to a mile and a quarter; but is commonly about three quarters of a mile.

The Ganges is fordable in ſome places above the conflux of the Jumnah, but the navigation is never interrupted. Below that, the channel is of conſiderable depth, for the additional ſtreams bring a greater acceſſion of depth than width. At 509 miles from the ſea, the channel is thirty feet deep when the river is at its loweſt; and it continues at leaſt this depth to the ſea, where the ſudden expanſion of the ſtream deprives it of the force neceſſary to ſweep away the bars of ſand and mud thrown acroſs it by the ſtrong ſoutherly winds; ſo that the principal branch of the Ganges cannot be entered by large veſſels.

About 220 miles from the ſea (but 300 reckoning the windings of the river) commences the head of the Delta of the Ganges, which is conſiderably more than twice the area of that of the Nile. The two weſternmoſt branches, named the

* This will be explained when the windings of the river are treated of.

Coſſimbuzar and Jellinghy Rivers, unite and form what is afterwards named the Hoogly River, which is the port of Calcutta, and the only branch of the Ganges that is commonly navigated by ſhips *. The Coſſimbuzar River is almoſt dry from October to May; and the Jellinghy River (although a ſtream runs in it the whole year) is in ſome years unnavigable during two or three of the dryeſt months; ſo that the only ſubordinate branch of the Ganges, that is at all times navigable, is the Chundnah River, which ſeparates at Moddapour, and terminates in the Hooringotta.

That part of the Delta bordering on the ſea, is compoſed of a labyrinth of rivers and creeks, all of which are ſalt, except thoſe that immediately communicate with the principal arm of the Ganges. This tract, known by the name of the Woods, or Sunderbunds, is in extent equal to the principality of Wales; and is ſo completely enveloped in woods, and infeſted with Tygers, that if any attempts have ever been made to clear it (as is reported) they have hitherto miſcarried. Its numerous canals are ſo diſpoſed as to form a compleat inland navigation throughout and acroſs the lower part of the Delta, without either the delay of going round the head of it, or the hazard of putting to ſea. Here ſalt, in quantities equal to the whole conſumption of Bengal and its dependencies, is made

* The Hoogly River, or weſternmoſt branch of the Ganges, has a much deeper outlet to the ſea than the principal branch. Probably this may be owing to its precipitating a leſs quantity of mud than the other; the quantity of the Ganges water diſcharged here being leſs than in the other in the proportion of one to ſix. From the difficulties that occur in navigating the entrance of the Hoogly River, many are led to ſuppoſe, that the channels are ſhallow. The difficulties, however, ariſe from bringing the ſhips acroſs ſome of the ſand-banks, which project ſo far into the ſea, that the channels between them cannot eaſily be traced from without.

and tranſported with equal facility: and here alſo is found an inexhauſtible ſtore of timber for boat-building. The breadth of the lower part of this Delta is upwards of 180 miles; to which, if we add that of the two branches of the river that bound it, we ſhall have about 200 miles for the diſtance to which the Ganges expands its branches at its junction with the ſea.

It has been obſerved before, that the courſe of this river, from Hurdwar to the ſea, is through an uniform plain, or, at leaſt, what appears ſuch to the eye: for, the declivity is much too ſmall to be perceptible. A ſection of the ground, parallel to one of its branches, in length 60 miles, was taken by order of Mr. HASTINGS; and it was found to have about nine inches deſcent in each mile, reckoning in a ſtraight line, and allowance being made for the curvature of the earth. But the windings of the river were ſo great, as to reduce the declivity on which the water ran, to leſs than four inches *per* mile: and by a compariſon of the velocity of the ſtream at the place of experiment with that in other places, I have no reaſon to ſuppoſe, that its general deſcent exceeds it *.

The medium rate of motion of the Ganges is leſs than three miles an hour in the dry months. In the wet ſeaſon, and during the draining off of the waters from the inundated lands, the current runs from five to ſix miles an hour; but there are inſtances of its running ſeven, and even eight miles, in particular ſituations, and under certain circumſtances. I have an

* M. DE CONDAMINE found the deſcent of the river Amazons, in a ſtraight courſe of about 1860 miles, to be about 1020 Engliſh feet, or 6½ inches in a mile. If we allow for the windings, it comes but nearly the ſame as the Ganges (which winds about 1½ mile in three, taking its whole courſe through the plains), namely, about 4 inches in a mile.

experiment

experiment of my own on record, in which my boat was carried 56 miles in eight hours; and that againſt ſo ſtrong a wind, that the boat had evidently no progreſſive motion through the water.

When we conſider, that the velocity of the ſtream is three miles in one ſeaſon, and five or more in the other, on the ſame deſcent of four inches *per* mile; and, that the motion of the inundation is only half a mile *per* hour, on a much greater deſcent; no further proof is required how ſmall the proportion of velocity is, that the deſcent communicates. It is then, to the impetus originating at the ſpring head, or at the place where adventitious waters are poured in, and ſucceſſively communicated to every part of the ſtream, that we are principally to attribute the velocity, which is greater or leſſer, according to the quantity of water poured in.

In common, there is found on one ſide of the river an almoſt perpendicular bank, more or leſs elevated above the ſtream, according to the ſeaſon, and with deep water near it: and on the oppoſite ſide a bank, ſhelving away ſo gradually as to occaſion ſhallow water at ſome diſtance from the margin. This is more particularly the caſe in the moſt winding parts of the river, becauſe the very operation of winding produces the ſteep and ſhelving banks *: for the current is always ſtrongeſt on the external ſide of the curve formed by the ſerpentine courſe of the river; and its continual action on the banks

* Hence it is, that the ſection of a river, that winds through a looſe ſoil, approaches nearly to an obtuſe angled-triangle, one of whoſe ſides is exceedingly ſhort and diſproportioned to the other two . But when a river perſeveres in a ſtraight courſe, the ſection becomes nearly the half of an ellipſis divided longitudinally .

either

either undermines them *, or waſhes them down. In places where the current is remarkably rapid, or the ſoil uncommonly looſe, ſuch tracts of land are ſwept away in the courſe of one ſeaſon, as would aſtoniſh thoſe who have not been eye-witneſſes to the magnitude and force of the mighty ſtreams occaſioned by the periodical rains of the tropical regions. This neceſſarily produces a gradual change in the courſe of the river; what is loſt on one ſide being gained on the other, by the mere operation of the ſtream: for the fallen pieces of the bank diſſolve quickly into muddy ſand, which is hurried away by the current along the border of the channel to the point from whence the river turns off to form the next reach, where the ſtream growing weak, it finds a reſting place, and helps to form a ſhelving bank, which commences at the point, and extends downwards, along the ſide of the ſucceeding reach.

To account for the ſlackneſs of the current at the point, it is neceſſary to obſerve, that the ſtrongeſt part of it, inſtead of turning ſhort round the point, preſerves for ſome time the direction given it by the laſt ſteep bank, and is accordingly thrown obliquely acroſs the bed of the river to the bay on the oppoſite ſide, and purſues its courſe along it, till the intervention of another point again obliges it to change ſides.

In thoſe few parts of the river that are ſtraight, the banks undergo the leaſt alteration †, as the current runs parallel to

* In the dry ſeaſon ſome of theſe banks are more than 30 feet high, and often fall down in pieces of many tons weight, and occaſion ſo ſudden and violent an agitation of the water, as ſometimes to ſink large boats that happen to be near the ſhore.

† It is more than probable, that the ſtraight parts owe their exiſtence to the tenacity of the ſoil of which their banks are compoſed, Whatever the cauſe may be, the effect very clearly points out ſuch ſituations as the propereſt for placing towns in.

them;

them; but the leaſt inflection of courſe has the effect of throwing the current againſt the bank; and if this happens in a part where the ſoil is compoſed of looſe ſand, it produces in time a ſerpentine winding.

It is evident, that the repeated additions made to the ſhelving bank before mentioned, become in time an encroachment on the channel of the river; and this is again counter-balanced by the depredations made on the oppoſite ſteep bank, the fragments of which, either bring about a repetition of the circumſtances above recited, or form a bank or ſhallow in the midſt of the channel. Thus a ſteep and a ſhelving bank are alternately formed in the crooked parts of the river (the ſteep one being the *indented* ſide, and the ſhelving one the *projecting*); and thus, a continual fluctuation of courſe is induced in all the winding parts of the river; each meander having a perpetual tendency to deviate more and more from the line of the general courſe of the river, by eating deeper into the bays, and at the ſame time adding to the points, till either the oppoſite bays meet, or the ſtream breaks through the narrow iſthmus, and reſtores a temporary ſtraightneſs to the channel.

Several of the windings of the Ganges and its branches are faſt approaching to this ſtate; and in others, it actually exiſts at preſent. The experience of theſe changes ſhould operate againſt attempting canals of any length, in the higher parts of the country; and I much doubt, if any in the lower parts would long continue navigable. During eleven years of my reſidence in Bengal, the outlet or head of the Jellinghy River was gradually removed three quarters of a mile farther down: and by two ſurveys of a part of the adjacent bank of the Ganges, taken about the diſtance of nine years from each other, it appeared that the breadth of an Engliſh mile and a half had been

taken

taken away. This is, however, the moſt rapid change that I have noticed; a mile in ten or twelve years being the uſual rate of incroachment, in places where the current ſtrikes with the greateſt force, namely, where two adjoining reaches approach neareſt to a right angle. In ſuch ſituations it not unfrequently excavates gulfs * of conſiderable length within the bank. Theſe gulfs are in the direction of the ſtrongeſt parts of the ſtream; and are, in fact, the *young ſhoots* (if I may ſo expreſs myſelf) which in time ſtrike out and become branches of the river; for we generally find them at thoſe turnings that have the ſmalleſt angles †.

Two cauſes, widely different from each other, occaſion the meandering courſes of rivers; the one, the irregularity of the ground through which they run, which obliges them to wander in queſt of a declivity; the other, the looſeneſs of the ſoil, which yields to the friction of the border of the ſtream. The meanders in the firſt caſe, are, of courſe, as digreſſive and irregular as the ſurface they are projected on: but, in the latter, they are ſo far reducible to rule, that rivers of unequal bulk will, under ſimilar circumſtances, take a circuit to wind in, whoſe extent is in proportion to their reſpective breadths: for I have obſerved, that

* The Count DE BUFFON adviſes the digging of ſuch gulfs in the banks of ordinary rivers, with a view to divert the current, when bridges or other buildings are endangered by it.

† The courſes of theſe branches at the efflux, generally, if not always, become retrograde to the courſe of the river: for, a ſand bank accumulating at the upper point of ſeparation, gives an oblique direction upwards, to the ſtream, which would otherwiſe run out at right angles. This ſand bank being always on the increaſe, occaſions a corroſion of the oppoſite bank; and by this means all, or moſt of the outlets have a progreſſive motion downwards; as I have before remarked of the Jellinghy River, in the foregoing page.

when a branch of the Ganges is fallen ſo low as to occupy only a part of its bed, it no longer continues in the line of its old courſe; but works itſelf a new channel, which winds from ſide to ſide acroſs the former one. I have obſerved too, that in two ſtreams, of equal ſize, that which has the floweſt current has alſo the ſmalleſt windings: for as theſe (in the preſent caſe) are ſolely owing to the depredations made on the banks by the force of the current; ſo the extent of theſe depredations, or, in other words, the dimenſions of the windings, will be determined by the degree of force acting on the banks.

The windings of the Ganges in the plains, are, doubtleſs, owing to the looſeneſs of the ſoil: and (I think) the proof of it is, that they are perpetually changing; which thoſe, originally induced by an inequality of ſurface, can ſeldom, or never do *.

I can eaſily ſuppoſe, that if the Ganges was turned into a ſtraight canal, cut through the ground it now traverſes in the moſt winding parts of its courſe, its ſtraightneſs would be of ſhort duration. Some yielding part of the bank, or that which happened to be the moſt ſtrongly acted on, would firſt be corroded or diſſolved: thus a bay or cavity would be formed in the ſide of the bank. This begets an inflection of the current, which, falling obliquely on the ſide of the bay, corrodes it inceſſantly. When the current has paſſed the innermoſt part of the bay, it receives a new direction, and is thrown

* It has been remarked, that the courſes of rivers become more winding as they approach the ſea. This, I believe, will only hold good in ſuch as take the latter part of their courſe through a ſandy ſoil. In the Ganges, and other rivers ſubject to conſiderable variations in the bulk of their ſtreams, the beſt marks of the vicinity of the ſea are, the lowneſs of the river banks, and the increaſing muddineſs of the ſhallows in its bed.

obliquely

obliquely towards the oppoſite ſide of the canal, depoſiting in its way the matter excavated from the bay, and which begins to form a ſhallow or bank contiguous to the border of the canal. Here then is the origin of ſuch windings as owe their exiſtence to the nature of the ſoil. The bay, ſo corroded, in time becomes large enough to give a new direction to the body of the canal: and the matter excavated from the bay is ſo diſpoſed as to aſſiſt in throwing the current againſt the oppoſite bank, where a proceſs, ſimilar to that I have been deſcribing, will be begun.

The action of the current on the bank will alſo have the effect of deepening the border of the channel near it; and this again increaſes the velocity of the current in that part. Thus would the canal gradually take a new form, till it became what the river now is. Even when the windings have leſſened the deſcent one half, we ſtill find the current too powerful for the banks to withſtand it.

There are not wanting inſtances of a total change of courſe in ſome of the Bengal rivers *. The Coſa River (equal to the Rhine) once ran by Purneah, and joined the Ganges oppoſite Rajemal. Its junction is now 45 miles higher up. Gour, the ancient capital of Bengal, ſtood on the banks of the Ganges.

Appearances favour very ſtrongly the opinion, that the Ganges had its former bed in the tract now occupied by the lakes and moraſſes between Nattore and Jaffiergunge, ſtriking out of its preſent courſe at Bauleah, and paſſing by Pootyah. With an equal degree of probability (favoured by tradition) we may trace its ſuppoſed courſe by Dacca, to a junction with the Burrampooter or Megna near Fringybazar; where the accumu-

* The Mootyjyl lake is one of the windings of a former channel of the Coſſimburar River.

lation of two ſuch mighty ſtreams probably ſcooped out the preſent amazing bed of the Megna *.

In tracing the ſea coaſt of the Delta, we find no leſs than eight openings; each of which, without heſitation, one pronounces to have been in its time the principal mouth of the Ganges. Nor is the occaſional deviation of the principal branch, probably, the only cauſe of fluctuation in the dimenſions of the Delta. One obſerves, that the Deltas of capital rivers (the tropical ones particularly) encroach upon the ſea. Now, is not this owing to the mud and ſand brought down by the rivers, and gradually depoſited, from the remoteſt ages down to the preſent time? The rivers, we know, are loaded with mud and ſand at their entrance into the ſea; and we alſo know, that the ſea recovers its tranſparency at the diſtance of twenty leagues from the coaſt; which can only ariſe from the waters having precipitated their earthy particles within that ſpace. The ſand and mud banks at this time, extend twenty miles off ſome of the iſlands in the mouths of the Ganges and Burrampooter; and in many places riſe within a few feet of the ſurface. Some future generation will probably ſee theſe banks riſe above water, and ſucceeding ones poſſeſs and cultivate them! Next to earthquakes, perhaps the floods of the tropical rivers produce the quickeſt alterations in the face of our globe. Extenſive iſlands are formed in the channel of the Ganges, during a period far ſhort of that of a man's life; ſo that the whole proceſs lies

* Megna and Burrampooter are names belonging to the ſame river in different parts of its courſe. The Megna falls into the Burrampooter; and, though a much ſmaller river, communicates its name to the other during the reſt of its courſe.

within

within the compaſs of his obſervation *. Some of theſe iſlands, four or five miles in extent, are formed at the angular turnings of the river, and were originally large ſand banks thrown up round the points (in the manner before deſcribed) but afterwards inſulated by breaches of the river. Others are formed in the ſtraight parts of the river, and in the middle of the ſtream; and owe their origin to ſome obſtruction lurking at the bottom. Whether this be the fragments of the river bank; a large tree ſwept down from it; or a ſunken boat; it is ſufficient for a foundation: and a heap of ſand is quickly collected below it. This accumulates amazingly faſt: in the courſe of a few years it peeps above water, and having now uſurped a conſiderable portion of the channel, the river borrows on each ſide to ſupply the deficiency in its bed; and in ſuch parts of the river we always find ſteep banks on both ſides †. Each periodical flood brings an addition of matter to this growing iſland; increaſing it in height as well as extenſion, until its top is perfectly on a level with the banks that include it: and at that period of its growth it has mould enough on it for the purpoſes of cultivation, which is owing to the mud left on it when the waters ſubſide, and is indeed a part of the œconomy which nature obſerves in fertilizing the lands in general.

Whilſt the river is forming new iſlands in one part, it is ſweeping away old ones in other parts. In the progreſs of this deſtructive operation, we have opportunities of obſerving, by means of the ſections of the falling bank, the regular diſtri-

* Accordingly, the laws reſpecting alluvion are aſcertained with great preciſion.

† This evidently points out the means for preventing encroachments on a river bank in the ſtraight parts of its courſe, viz. to remove the ſhallows in the middle of its channel.

bution

bution of the ſeveral ſtrata of ſand and earths, lying above one another in the order in which they decreaſe in gravity. As they can only owe this diſpoſition to the agency of the ſtream that depoſited them, it would appear, that theſe ſubſtances are ſuſpended at different heights in the ſtream, according to their reſpective gravities. We never find a ſtratum of earth under one of ſand; for the muddy particles float neareſt the ſurface *. I have counted ſeven diſtinct ſtrata in a ſection of one of theſe iſlands. Indeed, not only the iſlands, but moſt of the river banks wear the ſame appearance: for as the river is always changing its preſent bed, and verging towards the ſite of ſome former one now obliterated, this muſt neceſſarily be the caſe.

As a ſtrong preſumptive proof of the wandering of the Ganges from the one ſide of the Delta to the other, I muſt obſerve, that there is no appearance of *virgin* earth between the Tiperah Hills on the eaſt, and the province of Burdwan on the weſt; nor on the north till we arrive at Dacca and Bauleah. In all the ſections of the numerous creeks and rivers in the Delta, nothing appears but ſand and black mould in regular ſtrata, till we arrive at the clay that forms the lower part of their beds. There is not any ſubſtance ſo coarſe as gravel either in the Delta or nearer the ſea than 400 miles †, where a rocky point, a part of the baſe of the neighbouring hills, projects into the river; but out of the vicinity of the great rivers the ſoil is either red, yellow, or of a deep brown.

* A glaſs of water taken out of the Ganges, when at its height, yields about one part in four of mud. No wonder then that the ſubſiding waters ſhould quickly form a ſtratum of earth; or that the Delta ſhould encroach upon the ſea!

† At Oudanulla.

I come

I come now to the particulars of the annual ſwelling and overflowing of the Ganges *.

It appears to owe its increaſe as much to the rain water that falls in the mountains contiguous to its ſource, and to the ſources of the great northern rivers that fall into it, as to that which falls in the plains of Hindooſtan; for it riſes fifteen feet and a half out of thirty-two (the ſum total of its riſing) by the latter end of June: and it is well known, that the rainy ſeaſon does not begin in moſt of the flat countries till about that time. In the mountains it begins early in † April; and by the latter end of that month, when the rain-water has reached Bengal, the rivers begin to riſe, but by very ſlow degrees; for the increaſe is only about an inch *per* day for the firſt fortnight. It then gradually augments to two and three inches before any

* An opinion has long prevailed, that the ſwelling of the Ganges, previous to the commencement of the rainy ſeaſon in the flat countries, is in a great meaſure owing to the melting of the ſnow in the mountains. I will not go ſo far as totally to diſallow the fact; but can by no means ſuppoſe, that the quantity of ſnow water bears any proportion to the increaſe of the river.

† The vaſt collection of vapours, wafted from the ſea by the ſoutherly or ſouth-weſt monſoon, are ſuddenly ſtopped by the lofty ridge of mountains that runs from eaſt to weſt through Thibet. It is obvious, that the accumulation and condenſation of theſe vapours, muſt firſt happen in the neighbourhood of the obſtacle; and ſucceſſively in places more remote, as freſh ſupplies arrive to fill the atmoſphere. Hence the priority of commencement of the rainy ſeaſon in places that lie neareſt the mountains.

All the rivers that are ſituated within the limits of the monſoons, or ſhifting trade winds, are ſubject to overflowings at annually ſtated periods, like the Ganges: and theſe periods return during the ſeaſon of the ſoutherly wind, that being the only wind which brings vapours from the ſea; and this being periodical, the falls of rain muſt neceſſarily be ſo too.

The northerly wind, which blows only over the land, is dry; for no rain (except caſual ſhowers) falls during the continuance of that monſoon.

quantity

quantity of rain falls in the flat countries; and when the rain becomes general, the increaſe on a medium is five inches *per* day. By the latter end of July all the lower parts of Bengal, contiguous to the Ganges and Burrampooter, are overflowed, and form an inundation of more than a hundred miles in width; nothing appearing but villages and trees, excepting very rarely the top of an elevated ſpot (the artificial mound of ſome deſerted village) appearing like an iſland.

The inundations in Bengal differ from thoſe in Egypt in this particular, that the Nile owes its floods *entirely* to the rain-water that falls in the mountains near its ſource; but the inundations in Bengal are as much occaſioned by the rain that falls there, as by the waters of the Ganges; and as a proof of it, the lands in general are overflowed to a conſiderable height long before the bed of the river is filled. It muſt be remarked, that the ground adjacent to the river bank, to the extent of ſome miles, is conſiderably higher than the reſt of the country *, and ſerves to ſeparate the waters of the inundation from thoſe of the river until it overflows. This high ground is in ſome ſeaſons covered a foot or more; but the height of the inundation within, varies, of courſe, according to the irregularities of the ground, and is in ſome places twelve feet.

Even when the inundation becomes general, the river ſtill ſhews itſelf, as well by the graſs and reeds on its banks, as by its rapid and muddy ſtream; for the water of the inundation acquires a blackiſh hue, by having been ſo long ſtagnant

* This property of the bank is well accounted for by Count BUFFON, who imputes it to the precipitation of mud made by the waters of the river, when it overflows. The inundation, ſays he, purifies itſelf as it flows over the plain; ſo that the precipitation muſt be greateſt on the parts neareſt to the margin of the river.

amongſt

amongſt graſs and other vegetables: nor does it ever loſe this tinge, which is a proof of the predominancy of the rain water over that of the river; as the ſlow rate of motion of the inundation (which does not exceed half a mile *per* hour) is of the remarkable flatneſs of the country.

There are particular tracts of land, which, from the nature of their culture, and ſpecies of productions, require leſs moiſture than others; and yet, by the lowneſs of their ſituation, would remain too long inundated, were they not guarded by dikes or dams, from ſo copious an inundation as would otherwiſe happen from the great elevation of the ſurface of the river above them. Theſe dikes are kept up at an enormous expence; and yet do not always ſucceed, for want of tenacity in the ſoil of which they are compoſed.

During the ſwoln ſtate of the river, the tide totally loſes its effect of counteracting the ſtream; and in a great meaſure that of ebbing and flowing, except very near the ſea. It is not uncommon for a ſtrong wind, that blows up the river for any continuance, to ſwell the waters two feet above the ordinary level at that ſeaſon: and ſuch accidents have occaſioned the loſs of whole crops of rice *. A very tragical event happened at Luckipour † in 1763, by a ſtrong gale of wind conſpiring with a high ſpring tide, at a ſeaſon when the periodical flood was within a foot and half of its higheſt pitch. It is ſaid that the waters roſe ſix feet above the ordinary level. Certain it is, that

* The rice I ſpeak of is of a particular kind; for the growth of its ſtalk keeps pace with the increaſe of the flood at ordinary times, but is deſtroyed by a too ſudden riſe of the water. The harveſt is often reaped in boats. There is alſo a kind of graſs which overtops the flood in the ſame manner, and at a ſmall diſtance has the appearance of a field of the richeſt verdure.

† This place is ſituated about fifty miles from the ſea.

the inhabitants of a conſiderable diſtrict, with their houſes and cattle, were totally ſwept away; and, to aggravate their diſtreſs, it happened in a part of the country which ſcarce produces a ſingle tree for a drowning man to eſcape to.

Embarkations of every kind traverſe the inundation: thoſe bound upwards, availing themſelves of a direct courſe and ſtill water, at a ſeaſon when every ſtream ruſhes like a torrent. The wind too, which at this ſeaſon blows regularly from the ſouth-eaſt *, favours their progreſs; inſomuch, that a voyage, which takes up nine or ten days by the courſe of the river when confined within its banks, is now effected in ſix. Huſbandry and grazing are both ſuſpended; and the peaſant traverſes in his boat, thoſe fields which in another ſeaſon he was wont to plow; happy that the elevated ſite of the river banks place the herbage they contain, within his reach, otherwiſe his cattle muſt periſh.

The following is a table of the gradual increaſe of the Ganges and its branches, according to obſervations made at Jellinghy and Dacca.

	At Jellinghy.		At Dacca.	
	Ft.	In.	Ft.	In.
In May it roſe -	6	0	2	4
June - - -	9	6	4	6
July - - -	12	6	5	6
In the firſt half of Auguſt	4	0	1	11
	32	0	14	3

* Although in the gulf or bay of Bengal the monſoon blows from the S.S.W. and S.W. yet in the eaſtern and northern parts of Bengal it blows from the S.E. or E.S.E.

These observations were made in a season, when the waters rose rather higher than usual; so that we may take 31 feet for the medium of the increase.

The inundation is nearly at a stand for some days preceding the middle of August, when it begins to run off; for although great quantities of rain fall in the flat countries, during August and September, yet, by a partial cessation of the rains in the mountains, there happens a deficiency in the supplies necessary to keep up the inundation *. The quantity of the daily decrease of the river is nearly in the following proportion: during the latter half of August, and all September, from three to four inches; from September to the end of November, it gradually lessens from three inches to an inch and a half; and from November to the latter end of April, it is only half an inch *per* day at a medium. These proportions must be understood to relate to such parts of the river as are removed from the influence of the tides; of which more will be said by and by. The decrease of the inundation does not always keep pace with that of the river, by reason of the height of the banks; but after the beginning of October, when the rain has nearly ceased, the remainder of the inundation goes off quickly by evaporation, leaving the lands highly manured, and in a state fit to receive the seed, after the simple operation of plowing.

There is a circumstance attending the increase of the Ganges, and which, I believe, is little known or attended to; because few people have made experiments on the heights to which the

* I have stated the middle of August for the period when the waters begin to run off; and in general it happens with more regularity than the vicissitudes of the seasons do. But there are exceptions to it; for in the year 1774 the rivers kept up for near a month after the usual time.

periodical flood riſes in different places. The circumſtance I allude to, is, the difference of the quantity of the increaſe (as expreſſed in the foregoing table) in places more or leſs remote from the ſea. It is a fact, confirmed by repeated experiments, that from about the place where the tide commences, to the ſea, the height of the periodical increaſe diminiſhes gradually, until it totally diſappears at the point of confluence. Indeed, this is perfectly conformable to the known laws of fluids: the Ocean preſerves the ſame level at all ſeaſons (under ſimilar circumſtances of tide) and neceſſarily influences the level of all the waters that communicate with it, unleſs precipitated in the form of a cataract. Could we ſuppoſe, for a moment, that the increaſed column of water, of 31 feet perpendicular, was continued all the way to the ſea, by ſome preternatural agency: whenever that agency was removed, the head of the column would diffuſe itſelf over the Ocean, and the remaining parts would follow, from as far back as the influence of the Ocean extended; forming a ſlope, whoſe perpendicular height would be 31 feet. This is the preciſe ſtate in which we find it. At the point of junction with the ſea, the height is the ſame in both ſeaſons at equal times of the tide. At Luckipour there is a difference of about ſix feet between the heights in the different ſeaſons; at Dacca, and places adjacent, 14; and near Cuſtee, 31 feet. Here then is a regular ſlope; for the diſtances between the places bear a proportion to the reſpective heights. This ſlope muſt add to the rapidity of the ſtream; for, ſuppoſing the deſcent to have been originally four inches *per* mile, this will increaſe it to about five and an half. Cuſtee is about 240 miles from the ſea, by the courſe of the river; and the ſurface of the river there, during the dry ſeaſon, is about 80

feet

feet above the level of the ſea at high water *. Thus far does the Ocean manifeſt its dominion in both ſeaſons: in the one by the ebbing and flowing of its tides; and in the other by depreſſing the periodical flood, till the ſurface of it coincides as nearly with its own, as the deſcent of the channel of the river will admit †.

Similar circumſtances take place in the Jellinghy, Hoogly, and Burrampooter Rivers; and, I ſuppoſe, in all others that are ſubject either to periodical or occaſional ſwellings.

Not only does the flood diminiſh near the ſea, but the river banks diminiſh in the ſame proportion; ſo that in the dry ſeaſon the height of the periodical flood may be known by that of the bank.

I am aware of an objection that may be made to the above ſolution; which is, that the lowneſs of the banks in places near the ſea, is the true reaſon why the floods do not attain ſo conſiderable a height, as in places farther removed from it, and where the banks are high; for that the river, wanting a bank to confine it, diffuſes itſelf over the ſurface of the country. In

* The tides in the River Amazons are perceptible at 600 miles above its mouth; but at an elevation of only 90 feet, according to M. DE CONDAMINE. It remains to be told what the ſtate of the river was at the time of making the experiment; becauſe the land-floods have the effect of ſhortening the limits of the tide's way.

† The Count DE BUFFON has ſlightly mentioned this circumſtance attending the ſwelling of rivers; but imputes it to the increaſed velocity of the current, as the river approaches the ſea: which, ſays he, carries off the inundation ſo quick, as to abate its height. Now (with the utmoſt deference to ſo great an authority) I could never perceive, that the current, either in the Ganges, or any other river, was ſtronger near the ſea than at a diſtance from it. Even if we admit an acceleration of the current during the ebb tide, the flux retards it in ſo conſiderable a degree, as at leaſt to counter balance the effects produced by the temporary increaſe of velocity.

anſwer

anſwer to this, I ſhall obſerve, that it is proved by experiment, that at any given time, the quantity of the increaſe in different places, bears a juſt proportion to the ſum total of the increaſe in each place reſpectively: or, in other words, that when the river has riſen three feet at Dacca, where the whole riſing is about 14 feet; it will have roſe upwards of ſix feet and a half at Cuſtee, where it riſes 31 feet in all.

The quantity of water diſcharged by the Ganges, in one ſecond of time, during the dry ſeaſon, is 80,000 cubic feet; but in the place where the experiment was made, the river, when full, has thrice the volume of water in it; and its motion is alſo accelerated in the proportion of 5 to 3: ſo that the quantity diſcharged in a ſecond at that ſeaſon is 405,000 cubic feet. If we take the medium the whole year through, it will be nearly 180,000 cubic feet in a ſecond.

THE Burrampooter, which has its ſource from the oppoſite ſide of the ſame mountains that give riſe to the Ganges, firſt takes its courſe eaſtward (or directly oppoſite to that of the Ganges) through the country of Thibet, where it is named Sanpoo or Zanciu, which bears the ſame interpretation as the Gonga of Hindooſtan: namely, the River. The courſe of it through Thibet, as given by Father DU HALDE, and formed into a map by Mr. D'ANVILLE, though ſufficiently exact for the purpoſes of general geography, is not particular enough to aſcertain the preciſe length of its courſe. After winding with a rapid current through Thibet, it waſhes the border of the territory of Laſſa (in which is the reſidence of the grand Lama) and then deviating from an eaſt to a ſouth-eaſt courſe, it approaches within 220 miles of Yunan, the weſternmoſt province

of

of China. Here it appears, as if undetermined whether to attempt a paſſage to the ſea by the Gulf of Siam, or by that of Bengal; but ſeemingly determining on the latter, it turns ſuddenly to the weſt through Aſſam, and enters Bengal on the north-eaſt. I have not been able to learn the exact place where it changes its name; but as the people of Aſſam call it Burrampoot, it would appear, that it takes this name on its entering Aſſam. After its entry into Bengal, it makes a circuit round the weſtern point of the Garrow Mountains; and then, altering its courſe to ſouth, it meets the Ganges about 40 miles from the ſea.

Father DU HALDE expreſſes his doubts concerning the courſe that the Sanpoo takes after leaving Thibet, and only ſuppoſes generally that it falls into the gulf of Bengal. M. D'ANVILLE, his geographer, with great reaſon ſuppoſed the Sanpoo and Ava River to be the ſame: and in this he was juſtified by the information which his materials afforded him: for the Burrampooter was repreſented to him, as one of the inferior ſtreams that contributed its waters the Ganges, and not as its equal or ſuperior; and this was ſufficient to direct his reſearches, after the mouth of the Sanpoo River, to ſome other quarter. The Ava River, as well from its bulk, as the bent of its courſe for ſome hundred miles above its mouth, appeared to him to be a continuation of the river in queſtion: and it was accordingly deſcribed as ſuch in his maps, the authority of which was juſtly eſteemed as deciſive; and, till the year 1765, the Burrampooter, as a capital river, was unknown in Europe.

On tracing this river in 1765, I was no leſs ſurprized, at finding it rather larger than the Ganges, than at its courſe previous to its entering Bengal. This I found to be from the eaſt; although all the former accounts repreſented it as from the north:

north: and this unexpected diſcovery ſoon led to enquiries, which furniſhed me with an account of its general courſe to within 100 miles of the place where DU HALDE left the Sanpoo. I could no longer doubt, that the Burrampooter and Sanpoo were one and the ſame river: and to this was added the poſitive aſſurances of the Aſſamers, "That *their* river came "from the north-weſt, through the Bootan mountains." And to place it beyond a doubt, that the Sanpoo River is not the ſame with the river of Ava, but that this laſt is the great Nou Kian of Yunan; I have in my poſſeſſion a manuſcript draught of the Ava River, to within 150 miles of the place where DU HALDE leaves the Nou Kian, in its courſe towards Ava; together with very authentic information that this river (named Irabattey by the people of Ava) is navigable from the city of Ava into the province of Yunan in China *.

The Burrampooter, during a courſe of 400 miles through Bengal, bears ſo intimate a reſemblance to the Ganges, except in one particular, that one deſcription may ſerve for both. The exception I mean is, that, during the laſt 60 miles before its junction with the Ganges, it forms a ſtream which is regularly from four to five miles wide, and but for its freſhneſs might paſs for an arm of the ſea. Common deſcription fails in an attempt to convey an adequate idea of the grandeur of this magnificent object; for,

——— Scarce the muſe
Dares ſtretch her wing o'er this enormous maſs
Of ruſhing water; to whoſe dread expanſe,
Continuous depth, and wond'rous length of courſe,

* The courſes of the Burrampooter and Ganges, as well as that of the Ava River from Yunan to the ſea, will ſhortly be deſcribed in a large ſheet map of Hindooſtan.

Our

Our floods are rills
Thus pouring on, it proudly ſeeks the deep,
Whoſe vanquiſh'd tide, recoiling from the ſhock,
Yields to this liquid weight

THOMSON's Seaſons.

I have already endeavoured to account for the ſingular breadth of the Megna, by ſuppoſing that the Ganges once joined it where the Iſſamutty now does; and that their joint waters ſcooped out its preſent bed. The preſent junction of theſe two mighty rivers below Luckipour, produces a body of running freſh water, hardly to be equalled in the old hemiſphere, and, perhaps, not exceeded in the new. It now forms a gulf interſperſed with iſlands, ſome of which rival, in ſize and fertility, our Iſle of Wight. The water at ordinary times is hardly brackiſh at the extremities of theſe iſlands; and, in the rainy ſeaſon, the ſea (or at leaſt the ſurface of it) is perfectly freſh to the diſtance of many leagues out.

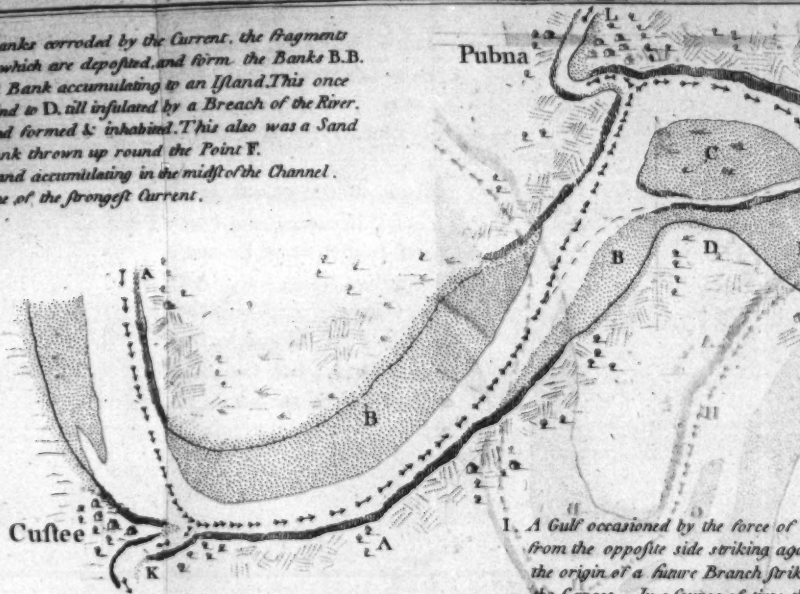
The *Bore* (which is known to be a ſudden and abrupt influx of the tide into a river or narrow ſtrait) prevails in the principal branches of the Ganges, and in the Megna; but the Hoogly River, and the paſſages between the iſlands and ſands ſituated in the gulf, formed by the confluence of the Ganges and Megna, are more ſubject to it than the other rivers. This may be owing partly, to their having greater embouchures in proportion to their channels, than the others have, by which means a larger proportion of tide is forced through a paſſage comparatively ſmaller; and partly, to there being no capital openings near them, to draw off any conſiderable portion of the accumulating tide. In the Hoogly or Calcutta River, the *Bore* commences at Hoogly Point (the place where the river firſt contracts itſelf)

and is perceptible above Hoogly Town; and ſo quick is its motion, that it hardly employs four hours in travelling from one to the other, although the diſtance is near 70 miles. At Calcutta, it ſometimes occaſions an inſtantaneous riſe of five feet; and both here, and in every other part of its track, the boats, on its approach, immediately quit the ſhore, and make for ſafety to the middle of the river.

In the channels, between the iſlands in the mouth of the Megna, &c. the height of the *Bore* is ſaid to exceed twelve feet; and is ſo terrific in its appearance, and dangerous in its conſequences, that no boat will venture to paſs at ſpring tide. After the tide is fairly paſt the iſlands, no veſtige of a *Bore* is ſeen, which may be owing to the great width of the Megna, in compariſon with the paſſages between the iſlands; but the effects of it are viſible, enough by the ſudden riſing of the tides.

PLAN of part of the Course of the GANGES, to explain

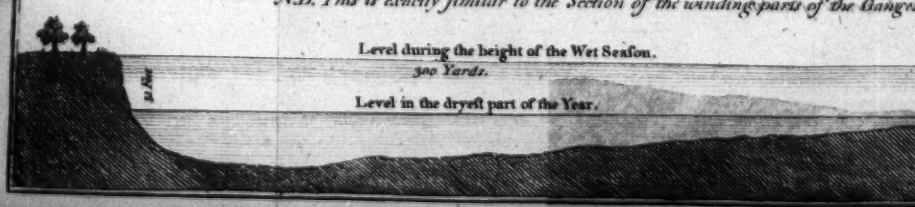
A A. Steep Banks corroded by the Current, the fragments of which are deposited, and form the Banks B.B.
C. A Sand Bank accumulating to an Island. This once joined to D. till insulated by a Breach of the River.
E. An Island formed & inhabited. This also was a Sand Bank thrown up round the Point F.
G. An Island accumulating in the midst of the Channel.
H. The line of the strongest Current.



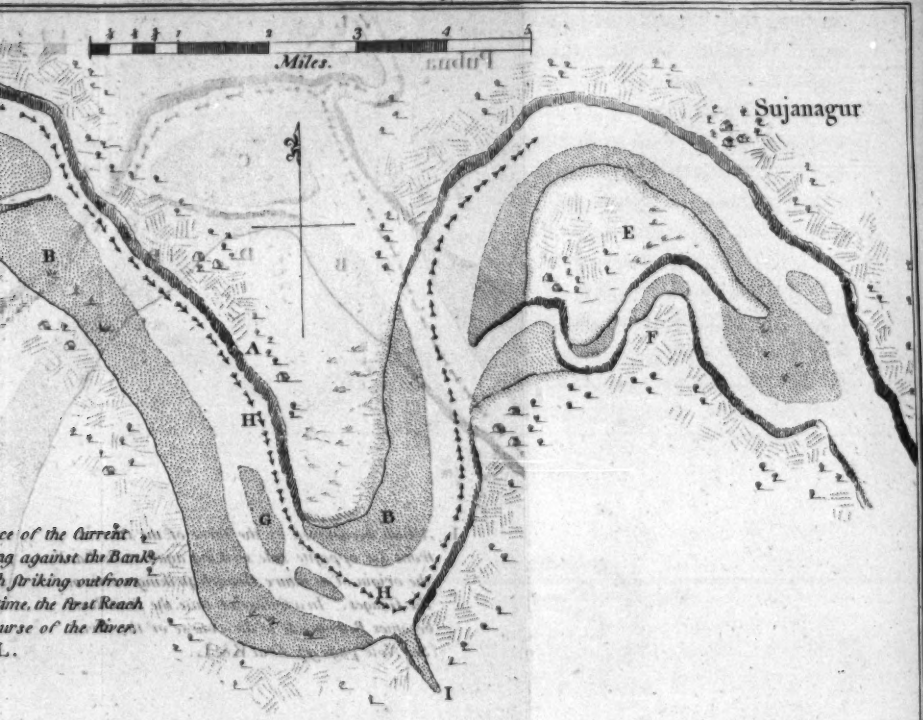
I. A Gulf occasioned by the force of from the opposite side striking ag the origin of a future Branch strik the Ganges. In a course of time, t becomes Retrograde to the Course (See Note page 97) as at K & L.

SECTION of a Branch of the GANGES, as a furth

N.B. This is exactly similar to the Section of the winding parts of the Ganges



Philos. Trans. Vol. LXXI. Tab. IV. p. 114.



ce of the Current
ng against the Bank
h striking outfrom
ime, the first Reach
urse of the River.
L.

further explanation of the steep and shelving Banks.

anges itself, except in the article of width.

X. *Aſtronomical Obſervations on the Rotation of the Planets round their Axes, made with a View to determine whether the Earth's diurnal Motion is perfectly equable. In a Letter from Mr.* William Herſchel *of* Bath *to* William Watſon, *M. D. F. R. S.*

Read January 11, 1781.

SIR, Bath, October 18, 1780.

THE various motions of the planet we inhabit; the annual revolution in its orbit; the diurnal rotation round its axis; the menſtrual motion round the common center of gravity of the moon and earth; the preceſſion of the equinoctial points; the diminution of the obliquity of the ecliptic; the nutation of the earth's axis: in ſhort, every one of the motions that ariſe from the actions of the ſun, moon, and planets, combined with the ſpheroidical figure of the earth, and the projectile and rotatory motions firſt impreſſed upon it, have all been conſidered by aſtronomers, and their real and apparent inequalities inveſtigated. And to the great honour of modern aſtronomers it muſt be confeſſed, that no ſcience has ever made ſuch conſiderable ſtrides towards perfection in ſo ſhort a time as aſtronomy has done ſince the invention of the teleſcope.

There is one of the motions of the earth however which, it ſeems, has hitherto eſcaped the ſcrutiny of obſervers; I mean the diurnal rotation round its axis. The principal reaſon

why this has not been looked into, is probably the difficulty of finding a proper ſtandard to meaſure it by; ſince it is itſelf uſed as the ſtandard by which we meaſure all the other motions. We have, indeed, no cauſe to ſuſpect any very material periodical irregularity, either diurnal, menſtrual, or annual; for the great perfection of our preſent time-pieces would have diſcovered any conſiderable deviation from that equability which we have hitherto aſcribed to the diurnal motion of the earth. And yet, it is not perhaps altogether impoſſible but that inequalities may exiſt in this motion which, in an age where obſervations are carried to ſuch a degree of refinement, may be of ſome conſequence.

To ſhew how far time-keepers, though ever ſo perfect, are from being a proper, or at leaſt a ſufficient, ſtandard to examine the diurnal motion of the earth by, I may aſk, whether it is probable, that any clock would have diſcovered to us the aberration of the fixed ſtars? And yet that aberration produces a change in longitude, and of conſequence in right aſcenſion, which cauſes an annual irregularity in a ſtar's coming to the meridian, which a time-piece, were it a ſufficient ſtandard, would ſoon have diſcovered, and which we might have attributed to an inequality of the earth's diurnal motion, had we not been acquainted with its real cauſe. And if we were to find out any apparent irregularity, acceleration, or retardation, ſhould we not much rather ſuſpect the clock than the diurnal motion? I may therefore venture to ſay, that the aberration of the fixed ſtars, though attended with the above mentioned conſequence, would for ever have remained a ſecret to us, if it had not been found out by other methods than time-keepers.

Now, if time-pieces do fail us in this critical caſe, where we ſtand in the greateſt need of their aſſiſtance, it is almoſt in vain

vain to expect any help from another quarter; for what mechanical movement on earth, or motion of the heavens, is there that can measure out such equal portions of time as we require to compare the diurnal motion of the earth to? However, to proceed, since we have already great proofs that the diurnal motion of the earth is, if not perfectly equable, at least more so than any other motion we are acquainted with, it will not appear absurd to suppose the diurnal rotation of the other planets to be so likewise. This suggested to me the thoughts of estimating the diurnal motion of one planet very exactly by that of another, making each the standard of the other. In this manner we may obtain a comparative view, by which future astronomers, if they shall hereafter be inclined to pursue the subject, may be enabled to make some estimate of the general equability of the rotatory motions of the planets. For if in length of time they should perceive some small retardation in the diurnal motion of a planet occasioned by some resistance of a very subtle medium in which the heavenly bodies perhaps move; or, on the other hand, if there should be found an acceleration from some cause or other, they might then ascribe the alteration either to the diurnal motion of the earth, or to the gyration of the other planet, according as circumstances, or observed phænomena, should make one or the other of these opinions most probable.

Now, this method of comparing together different rotations of several planets, simple as it may appear, was not without some difficulties. In the first place it was evident, that the common account of their diurnal motions *, which makes that

* Venus spatio 23 horarum gyrationem circa axem ab occidente in orientem perficit. Mars similem rotationem, horis 24 min. 40 absolvit. Maculatum revolutionibus sæpius observatis, Ds. CASSINI comperuit periodum Jovis circa proprium Axem esse horarum 9, minutorum 56. KEILL, Ast. Lect. V.

of

of Jupiter 9 h. 56′, of Mars 24 h. 40′, how true ſoever it may be in a general way, was much too inaccurate for this critical purpoſe. The gyration of Venus was ſtill leſs to be depended upon, being only noted to the hour without the minutes: it became, therefore, neceſſary to proceed to obſervations of a more determinate kind. From what I had already ſeen of the rotation of the planets, I concluded, that Mars on ſeveral accounts would be the moſt eligible planet for my purpoſe: for the ſpots on Jupiter change ſo often that it is not eaſy, if at all poſſible, to aſcertain the identity of the ſame appearance, for any conſiderable length of time. Nor do the dark ſpots only change their place, which may be ſuppoſed to be large black congeries of vapours and clouds ſwimming in the atmoſphere of Jupiter; but alſo the bright ſpots, though they may adhere firmly to the body of Jupiter, may undergo ſome apparent change of ſituation by being differently covered or uncovered on one ſide or the other, by alterations in the belts. It will be ſeen hereafter, that I have obſerved the revolution of a very bright ſpot, not ſuſpected of any change of ſituation, to be firſt, by one ſet of obſervations, at the rate of 9 h. 51′ 45″,6; and afterwards, by another ſet immediately following at the rate of 9 h. 50′ 48″.

As the principal belts on Jupiter are equatorial, and as we have certain conſtant winds upon our planet, eſpecially near the equator, that regularly, for certain periods, blow the ſame way *, it is eaſily ſuppoſed, that they may form equatorial belts by gathering together the vapours which ſwim in our atmoſphere, and carrying them about in the ſame direction. This will, by analogy, account for all the irregularities of Ju-

* See Acta Eruditorum, 1687. Dr. HALLEY's Account of periodical Winds.

piter's revolutions, deduced from ſpots on his diſk that may have changed their ſituation; for if we ſuppoſe the rotation of Jupiter, according to CASSINI, to be 9 h. 56′, then ſome ſpots that I have obſerved muſt have been carried through about 60° of Jupiter's equator in 22 of his revolutions or days. This would certainly be a very great velocity in the clouds, which is, however, not unparalleled by what has happened in our own atmoſphere.

But to return to my purpoſe: on the planet Mars we ſee ſpots of a different nature; their conſtant and determined ſhape, as well as remarkable colour, ſhew them to be permanent and faſtened to the body of the planet. Theſe will give the revolution of his equator to a great certainty, and by a great number of revolutions, to a very great exactneſs alſo. Suppoſing then, that, by a method I ſhall hereafter deſcribe, we can determine whether a ſpot on the diſk of Mars is, or is not, in the line which joins the center of the earth and the center of that planet, to half an hour's time with certainty (I believe ten or twelve minutes will be found ſufficient for that purpoſe), in this caſe we ſhall in 30 days have the revolution true to a minute; and, by continuing theſe obſervations for three months, we ſhall have it to 20″. When we are ſo far certain, we can eaſily arrive to a much greater degree of exactneſs; for as we now can no longer miſtake a whole revolution, if we take the time of any particular ſpot's being in the line which joins the centers of the planets during one oppoſition of Mars, and take the ſame again at or near the next oppoſition, we ſhall have an interval of about 780 days, which will give the diurnal motion of that planet true to about 2″. The next oppoſition will give it to one, and ſo forth; by which means, and by taking a proper number of ſuch periods, we may determine the rotation of Mars

Mars to as great an exactneſs as we ſhall think neceſſary for the purpoſe of our comparative view.

Had ſuch obſervations as theſe been made two thouſand, or perhaps only ſo many hundred years ago, we might now, by repeating them, moſt probably become acquainted with ſome curious minute changes of the ſolar ſyſtem that have hitherto paſſed unnoticed.

There is a certain circumſtance which would almoſt create a ſuſpicion that there has been ſome retardation in the diurnal motion of the earth. The difference between the equatorial and polar diameters of the earth, by actual meaſurement, has been found to be about 36 Engliſh miles and 9 tenths; but, by a calculation wherein the preſent rotation is made uſe of, it will only amount to about 33 miles and 8 tenths: from which it ſhould ſeem probable, that when the earth aſſumed the preſent form, the diurnal rotation was ſomewhat quicker than it is at preſent, by which means the centrifugal force bore a greater proportion to the force of gravity to which it is contrary, and thus occaſioned a higher elevation of the equatorial parts. But I would not lay much ſtreſs upon this argument; for, in the calculation, it has been ſuppoſed, that the earth is nearly of an equal denſity at the ſurface and towards the center, which it ſeems is not agreeable to ſome late curious experiments and calculations that have been made under the conduct of the Aſtronomer Royal upon the attraction of a mountain *, the reſult of which ought now to be taken into conſideration, and the calculation repeated. If all the *data* could be exactly depended upon, it would be practicable enough from the laws of

* See Mr. HUTTON's Account of the Calculations made from the Survey and Meaſures taken at Schehallien, in order to aſcertain the mean Denſity of the Earth. Phil. Tranſ. 1778.

gravity, and the preſent rotation and given form of the earth, to find the centrifugal force required to produce that form, and thence to ſhew what muſt have been its diurnal motion when it aſſumed the ſame. However, theſe are reſearches that in my preſent ſituation I neither have opportunity nor perhaps ability enough to inveſtigate properly; and which, therefore, I hope ſome of our excellent mathematicians will think worth while to look into.

I ſhall now relate my obſervations on Jupiter and Mars. The teleſcopes I uſed are of my own conſtruction; and are, a twenty-feet Newtonian reflector, a ten-feet reflector of the ſame form, and a ſeven-feet reflector already mentioned in my paper on the mountains of the moon. My time I gained by equal altitudes taken with a braſs quadrant of two-feet radius, carrying a teleſcope which magnifies about 40 times; for the correction of altitudes taken of the ſun I uſed DE LA LANDE's tables. I kept my time by two very good pieces; one having a deal pendulum-rod, the other a compounded one of braſs and iron, both having a proper contrivance not to ſtop when winding up. The rate of going of my clocks I determined by the tranſit of ſtars.

Obſervations on Jupiter in the year 1778.

February 24. Clock 1′ 10″ too ſoon. About 9 o'clock I ſaw a bright belt on one part of the diſk of Jupiter, ſee tab. V. fig. 1.

About 10 o'clock it was advanced as far as the center, fig. 2.

11 h. The white belt ſtill more advanced, fig. 3.

11 h. 25′. It approached towards the edge of the diſk; and at 12 h. was extended all over, as in fig. 4.

February 25. 8 h. The ſame bright belt I obſerved yeſterday extends all over.

8 h. 45′. It is divided by a darkiſh ſpot, ſituated at ſome diſtance from the center, as in fig. 5.

9 h. 5′. The ſmall dark diviſion is advanced a little farther than the center, as in fig. 6.

9 h. 23′. The ſpot is viſibly advanced a conſiderable deal farther.

March 2. 8 h. 2′. The darkiſh ſpot, with ſome alteration in its ſhape, is now in the middle of the diſk, ſee fig. 7.

March 3. 10 h. 34′. The bright belt on the ſouth of the equator is now in the middle; that is to ſay, if a line be drawn perpendicular to the equatorial belt, and through the center, the end of the equatorial belt now touches it, fig. 8.

13 h. 49′. The darkiſh ſpot, in which there has been ſome alteration ſince yeſterday, ſeems now to be in the center, fig. 9.

March 14. The clock altered to true equated time; but the rate of going not changed, being well regulated.

7 h. 35′. The ſpot is now in the center, but does not ſeem quite to fill the white belt; nor is it ſo large and diſtinct as it was before, fig. 10.

April 7. 9 h. 31′. There are three dark ſpots in the equatorial belt nearly in the center, ſee fig. 11.

April 12. 7 h. 50′. The three dark ſpots are in the center. The ſourthernmoſt of the three is nearly quite vaniſhed; the other two are alſo much fainter. They are, however, diſtinct enough to be known, fig. 12.

Obſervations

Obſervations on Jupiter in 1779.

April 14. Clock 52″ too late. 8 h. 48′ A remarkable bright ſpot in the equatorial belt towards the north is in the center, ſee fig. 18.

8 h. 58′. The ſpot is a little paſt the center.

April 19. Clock true mean time. 7 h. 10′. There is a bright ſpot juſt now in the center, which, from its ſhape, I take to be the ſame that was there April 14th.

7 h. 20′. The ſpot is viſibly paſt the center.

April 23. Clock ſhews true time. 9 h. 38′. The ſame bright ſpot is in the center.

9 h. 43′. It is paſt the center. *Memorandum*, my time-piece may be depended upon to a few ſeconds.

It will not be amiſs to obſerve, that the ſpots, as well as a great many other phænomena, were watched as they came on, paſſed over the center, and went off the diſk of Jupiter; but I have only ſelected thoſe obſervations that were neceſſary to my preſent purpoſe.

Comparing together the obſervations that were made in the year 1778, February 24th and March 3d, we obtain an interval of 7 days 34 minutes, which being divided by 17 revolutions made by Jupiter on his axis, we have the time of one ſynodical revolution equal to 9 h. 54′ 56″,4.

The dark ſpot on February 25 was obſerved ſome time before, and alſo juſt after it was paſt the center; therefore I have ſuppoſed it to be in the center about 8 h. 58′: and we have,

	D.	H.	M.
February	25	8	58
March	2	8	2
Divided by 12 rev.	4	23	4

1 revolution = 9 h. 55′ 20″

February	25	8	58
March	3	13	49
15 revol.	6	4	51

1 revolution = 9 h. 55′ 24″.

February	25	8	58	0
March	14	7	36	10 allowing 1′ 10″ for the alt. of the clock.
41 revol.	16	22	38	10

1 revolution = 9 h. 55′ 4″,6.

March	2	8	2
	3	13	49
1 revol.	1	5	47

1 revolution = 9 h. 55′ 40″.

March	2	8	2	0
	14	7	36	10
29 revol.	11	23	34	10

1 revolution = 9 h. 54′ 58″,2.

March

	D.	H.	M.	S.
March	3	13	49	0
	14	7	36	10
Divided by 26 rev.	10	17	47	10

1 revolution = 9 h. 54′ 53″,4.

April	7	9	31
	12	7	50
12 revol.	4	22	29

1 revolution = 9 h. 51′ 35″.

Again, comparing together the obſervations of 1779, which were made with the utmoſt attention to time, we have,

April	14	8	48	52
April	19	7	10	0
12 revol.	4	22	21	8

1 revolution = 9 h. 51′ 45″6.

April	19	7	10
April	23	9	38
10 revol.	4	2	28

1 revolution = 9 h. 50′ 48″.

And taking both together,

April	14	8	48	52
April	23	9	38	0
22 revol.	9	0	49	8

1 revolution = 9 h, 51′ 19″,4.

Theſe

Theſe ſeveral reſults are ſo exceedingly various, that it is evident Jupiter is not a proper planet for the critical purpoſe of a comparative view of the diurnal motions; nor can this great variety proceed from any inaccuracy in the obſervations: for, in my opinion, it is not well poſſible to make a miſtake in the ſituation of a ſpot that ſhall amount to ſo much as five minutes of time. The obſervation of April 23, 1779, was made with a view to aſcertain this point, when it was found that five minutes of time made a ſenſible difference in the ſituation of a ſpot when near the center.

If we reduce the ſynodical revolutions to ſydereal ones, the reſult will be ſo little different from the above, that I have not thought it worth while to do it in this place. By a compariſon of the different periods it appears, that a ſpot which is carried about in the atmoſphere of Jupiter generally ſuffers an acceleration, or, which is the ſame thing, performs its revolutions by degrees in leſs time than it did at firſt; for the ſpot obſerved in 1778 moved at the following rates. From February 25. to March 2. in 9 h. 55′ 20″; to March 3. nearly the ſame; to March 14. in 9 h. 55′ 4″; from March 2. to March 3. in 9 h. 55′ 40″; to March 14. in 9 h. 54′ 58″; from March 3. to March 14. in 9 h. 54′ 53″. In 1779 a ſpot moved from April 14. to April 19. at the rate of 9 h. 51′ 45″; to April 23. in 9 h. 51′ 24″; and from April 19. to April 24. in 9 h. 50′ 48″; all which is agreeable enough to the theory of equatorial winds, ſince it may probably take up ſometime before a ſpot can acquire a ſufficient velocity to go as faſt as thoſe winds may blow. And, by the by, if Jupiter's ſpots ſhould be obſerved in different parts of his year, and be found in ſome to be accelerated, in others to be retarded, it would almoſt amount to a demonſtration of his monſoons and their periodical changes; but if his

axis ſhould not be inclined enough to his orbit, to occaſion ſuch a change, they may probably always blow in the ſame direction.

Obſervations on Mars in the year 1777.

Twenty-feet Newtonian reflector; power 300.

April 8. 7 h. 30′. I obſerved two ſpots upon Mars, with a bright belt or partition between them. The belt was not very well defined, ſee tab. VI. fig. 14.

9 h. 30′. The ſpots are advanced, and more ſpotted parts are viſible, fig. 15.

10 h. The revolution of Mars on his axis is now very evident, fig. 16.

April 17. Ten-feet Newtonian reflector; power about 211. 7 h. 50′. Mars appeared as in fig. 17. At *a* and *b* there were two bright ſpots, ſo luminous that they ſeemed to project beyond the diſk. At *c* and *d* there were two very dark ſpots, joined by a leſſer black line in the middle, which however was croſſed at *e* and *f* by a very faint whitiſh partition.

April 26. Ten-feet reflector; power 211.

9 h. 5′. The ſpots on the planet are very faint, and much about as in fig. 18.

April 27. Ten-feet reflector; power 324.

8 h. 40′. The evening very fine: my teleſcope in compleat order. The ſpots as in fig. 19.

Obſervations

Obſervations on Mars in the year 1779.

May 9th. Clock 15″ too faſt; by equal altitudes on the 14th of April, and by the tranſit of a ſtar, is found to loſe 1″,45 *per* day.

11 h. 1′ by the clock, I found the ſituation of the ſpots on Mars as in figure 20; there is a very remarkable dark ſpot not far from the center.

11 h. 30′. The figures are gone from the center.

May 11. Clock 12″ too faſt.

10 h. 18′. The ſame ſpot that was viſible May 9. is on the diſk, the darkeſt place being intirely ſouth-eaſt of the center, ſee fig. 21.

11 h. 43′. The darkeſt part is almoſt arrived at the center, fig. 22.

12 h. 17′. The dark ſpot is with its edge juſt near the center, as in fig. 23.

May 13. Seven-feet reflector; power 222. Clock 9″ too faſt.

11 h. 26′. Mars ſeems now to be in the ſame ſituation he was the 11th, at 10 h. 8′.

May 22. Clock 4″ too ſlow.

12 h. 5′. The figure of May 11th is not on the diſk; but ſome other fainter ſpots are viſible. The air is full of vapours.

June 6. The clock ſet by ten equal altitudes taken to-day, and by the tranſit of δ Scorpii loſes 1″,9 *per* day. What I have perhaps improperly called a tranſit is the occultation of a ſtar paſſing behind the perpendicular edge of a high building at about 40 yards diſtance, obſerved with a fixed teleſcope directed to the place where it vaniſhes.

10 h. 10′. The ſame figure is upon the diſk of Mars which was there April 8, 1777, at 7 h. 30′.

June

June 15. Clock 17″ too ſlow. 9 h. 45′. The ſame figure is upon Mars that was there May 9. at 11 h. 1′; but it is more advanced. I ſuppoſe it to be the ſame, and in the ſame ſituation, as April 17, 1777, at 7 h. 50′.

June 17. Clock 20″ ſlow.

9 h. 12′. The dark ſpot on Mars is rather more advanced than it was May 11th, at 10 h. 18′.

10 h. The ſpot is viſibly advanced: I ſuppoſe it will take near an hour to come to the center.

10 h. 15′. A very thick fog obſcures the ſky.

11 h. 15′. The ſame darkneſs.

June 19. Clock 22″ too ſlow by the tranſit of δ Scorpii obſerved this evening.

8 h. 40′. The figure on the diſk of Mars appears now to be as it was April 26, 1777, at 9 h. 5′, ſee fig. 18.

11 h. 30′. The figure of May 11. which I have been hitherto watching, is not come to the poſition it was then at 11 h. 43′, but cannot be far from it. I fear, as Mars approaches the horizon, I ſhall not be able to follow him till the figure comes to the center.

11 h. 47′. The ſtate of the air near the horizon is very unfavourable. With much difficulty I can but juſt ſee that the figure is not quite ſo far advanced as it was May 11th, at 11 h. 43′, but can certainly not be above two or three minutes from it.

11 h. 51′. The undulation of the air prevents all further obſervation.

Let us now examine the reſult of the above mentioned obſervations: comparing together the two following ſhort intervals of the year 1779, we have,

	D.	H.	M.	S.
From May	9	11	0	45
to May	11	12	16	48
Divided by 2 revol.	2	1	16	3

Gives 1 revolution = 24 h. 38′ 1″,5.

A ſecond ſmall interval.

May	11	10	17	48
	13	11	25	51
2 revol.	2	1	8	3

1 revolution = 24 h. 34′ 1″,5.

Here we have two very ſhort intervals that agree to 4′, which is more than we could have expected in ſuch ſhort periods of time.

Comparing together obſervations that were made at a greater diſtance, we find,

First monthly period,

May	11	10	17	48	
June	17	9	9	20	allowing 3′ becauſe the obſ. ſays the ſpot was rather more advanced.
36 revol.	36	22	51	32	

1 revolution = 24 h. 38′ 5″,9.

Second monthly period,

May	11	11	42	48	
June	19	11	50	22	allowing 3′ for the time the ſpot would have taken to come to the place mentioned.
38 revol.	39	0	7	34	

1 revolution = 24 h. 38′ 5″,4.

Third

Third monthly period,

	D.	H.	M.	S.
May	13	11	25	51
June	17	9	9	20
34 revol.	34	21	43	29

1 revolution = 24 h. 38′ 20″,3

This laſt is, perhaps, as likely to be near the truth as any, ſince the ſame ſpot was here obſerved for the third time, and therefore its motion become more familiar.

Here we have three longer periods that agree to fifteen ſeconds, which is quite ſufficient for extending the interval of time to thoſe obſervations that were made in the year 1777. But as theſe are the ſynodical revolutions, it will be neceſſary firſt to reduce them to ſydereal rotations.

In figure 24. let us ſuppoſe the orbit of Mars, MABC, to be in the ſame plane with the orbit of the earth, EDFG; and the axis of Mars to be perpendicular to his orbit. Let M, E, *m*, *e*, be the ſituations of Mars and the earth on the 13th of May and 17th of June; then will the line EM, that connects the centers of Mars and the earth, point out the geocentric place of Mars on the 13th of May; and the line *em*, the geocentric place of the ſame planet on the 17th of June. Draw *er* and *ms* parallel to ER; then will *er* point out the geocentric place of Mars on the 13th of May; and the angle *sme* is equal to the angle *mer*. Now, by an ephemeris * the geocentric place of Mars, May 13. at 11 h. 26′ was 7 ſ. 20 d. 59′ 21″;

* The Nautical Almanac gives the geocentric place of Mars only to every ſixth day; for which reaſon I uſed WHITE's Ephemeris, where it is given for every day, though perhaps not with ſo much exactneſs as I could wiſh.

and on the 17th of June, at 9 h. 9′, it was 7 ſ. 12 d. 27′ 22″, by which we obtain the difference or angle *rem* = *ems* = 8 d. 31′ 59″.

Now a ſpot on Mars, ſituated in the direction ME, will have made a ſydereal revolution when it returns to the ſame, or a parallel direction *ms*. From which we gather, that the ſpot on the 17th of June, after coming to the line *me*, where it finiſhes the ſynodical revolution, will have to go through an arch of 8 d. 31′ 59″, in order to arrive into the direction of the line *ms*, where it finiſhes the ſydereal rotation. The time it will take to go through this arch, at the ſydereal rate of 24 h. 39′ 20″ to 360 degrees, or 4″,109 *per* minute of a degree, will be 35′ 3″,8; this being divided by the numbers of revolution 34, gives 1′ 1″,8; which, added to 24 h. 38′ 20″,3, gives us 24 h. 39′ 22″,1 for the ſydereal revolution of Mars, as found by the third of the monthly periods. This quantity will help us to find a proper diviſor for the three following long biennial periods.

It is to be obſerved, that Mars has been retrograde in the above example, for which reaſon the meaſure of the angle *ems* was to be added to the ſynodical revolution when we wanted to find the ſydereal rotation; but if he had been direct, or if his place had been more advanced in the ecliptic than that to which we compared it, as at μ, then the line $\mu\sigma$ parallel to EM would be the direction to which the ſpot ſhould return, in order to accompliſh a ſydereal revolution, and therefore the quantity of the angle $\sigma\mu e = \mu er$, or difference of the geocentric places ought to be ſubtracted from the ſynodical revolution to obtain the ſydereal one.

		D.	M.	S.
First biennial period,	1777, April 8	7	30	
	1779, June 6	10	10	
		789	2	40

The geocentric places of Mars at those times were,

S.	D.	′	″
6	6	31	26
7	13	48	30
1	7	17	4

turned into time at 4″,109 *per* minute of a degree and subtracted, because Mars is more advanced in the ecliptic, is

789	2	40	0
—	2	33	11,8

Divided by 768 rev. 789 0 6 48,2

1 revolution = 24 h. 39′ 23″,03.

		D.	H.	M.	S.
Second biennial period,	1777, April 17	7	50	0	
	1779, June 15	9	45	17	
		789	1	55	17

	S.	D.	′	″
Geocentric places	6	3	31	27
	7	12	40	23
	1	9	8	56

Turned into time	789	1	55	17
and subtracted	—	2	40	52
768 revol.	788	23	14	25

1 revolution = 24 h. 39′ 18,″94.

Third

		D.	H.	M.	S.
Third biennial period,	1777, April	26	9	5	0
	1779, June	19	8	40	22
		783	23	35	22

	S.	D.	′	″
Geocentric places	6	1	24	36
	7	12	31	48
	1	11	7	12

Turned into time	783	23	35	22
and ſubtracted	—	2	45	15,6
763 revol.	783	20	50	6,4

1 revolution = 24 h. 39′ 23″,04.

As theſe three periods are ſupported by obſervations of equal validity, I ſhall take a mean of them all for the neareſt approximation to the true ſydereal revolution of Mars on his axis, which therefore is 24 h. 39′ 21″,67.

It remains now only to ſee how far we may depend upon this determination of Mars's diurnal rotation as coming near the truth; and looking over thoſe cauſes which may poſſibly produce any errors, we find, firſt of all, that in the long biennial periods a miſtake in the number of revolutions would produce a conſiderable deviation from truth. Secondly, in the obſervations of a ſpot which moves ſo ſlow, we are alſo liable to ſome conſiderable miſtake in eſtimating the time when it comes to a certain place; and the more ſo, if that place is not the center. Laſtly, the time itſelf is liable to inaccuracy.

As to the first, it appears from the three monthly periods observed in the year 1779, when the proper allowances for the geocentric places are made, that the sydereal revolution of Mars cannot well be less than 24 h. 39′ 5″, nor more than 24 h. 39′ 22″; but if we should divide any one of the three biennial periods by a supposed number of revolutions, only one more or one less than we have done, the difference would be so considerable, that nothing but a mistake in every one of the three monthly periods, of at least one whole hour, could justify such a supposition; and that such a mistake in the situation of a spot on Mars cannot have been made in those observations, I think, is evident enough from the exactness with which they were made, and from their agreement with each other.

The second cause of error, which is the uncertainty in assigning the exact time when a spot comes to the center, is of some force. But it seems to me highly probable, from the manner in which I have seen the spots on Mars pass over the disk of that planet, that there can hardly be so great an error as 10′ in an observation of any remarkable spot's coming to the center. However, not being willing to trust more to the eye than I ought to do, I had recourse to the following experiment. I drew several circles of one inch radius, taking care to make no visible impression of a center; and placed in each a fine point at the several distances of .0424, .0636, .0848, in ten thousands of an inch from the real center; some to the right, others to the left. These measures are the sines to radius one, of 2° 26′, 3° 39′, and 4° 52′, which are the arches a spot on Mars passes over in 10, 15, 20′ minutes respectively. I exposed them to several persons unacquainted with my designs, and found, that not one of them made a single mistake in saying whether the point was, or was not, in the center of the circle,

circle, and which way it deviated from it. As the direction of the motion of a ſpot on Mars is known, I thought the perſons who were to judge of the place of the points were intitled to be acquainted with the line in which they were placed, which for that reaſon was always to the right and left only. The points that anſwer to the excentricity of 15 and 20′ are indeed ſo viſibly out of the center, that I believe we may ſafely ſay, that any miſtake, in eſtimating the time of a ſpot on Mars coming to the center, cannot well exceed a quarter of an hour at the outſide.

As for the third and laſt occaſion of error, the time itſelf, I believe my manner of obtaining and keeping it in the year 1779 will appear ſatisfactory, and may, I think, be depended upon to a few ſeconds; but the obſervations of the year 1777, indeed, are far from having the ſame advantage. I was not then provided with an altitude inſtrument, therefore ſet my clock by a good ſun-dial, with the equation of time contained in the Nautical Almanac, and found it to agree generally to a minute or two with the time calculated for the eclipſes of Jupiter's firſt ſatellite, as I deduced it for Bath from the Nautical Almanac. However, it was certainly liable to an error of ſeveral minutes; therefore, allowing no leſs than 10′ for the clock in 1777, and 20′ for an error in eſtimating the ſituation of a ſpot in 1779, it will both amount to half an hour: then, if we take a mean of the three numbers, whereby we have divided the three biennial periods, we have 766$\frac{1}{3}$; and half an hour, divided by 766$\frac{1}{3}$, will therefore give us the quantity to which, it ſeems, can amount, all the uncertainty in the ſydereal diurnal rotation of Mars, which is 2″,34.

A nearer approximation to truth I hope to obtain at the next oppoſition, which will happen about the middle of July 1781.

I have ventured to calculate the times for that oppoſition, when the edge of the remarkable dark ſpot will be ſeen near the center, as it is in figure 23, or, which is the ſame thing, as it was the 11th of May 1779, at 12 h. 17′. The ſpot not being viſible at the time of the oppoſition, I have taken the neareſt period, before and after, in which it will paſs over the diſk. There is, however, a circumſtance which may make the appearance of the ſpot not quite ſimilar to the figure I have drawn, even though the rotations ſhould perfectly anſwer as to the times; for the poſition of the axis of Mars being ſtill in ſome meaſure unknown, I could make no allowance for a change, which a difference in the ſituation of no leſs than two ſigns may occaſion, though in all probability it will not be very conſiderable.

Thoſe who are provided with proper teleſcopes will have an opportunity to ſee how far the calculated times agree with the ſpot's appearance; and it is by this means I alſo hope to correct and improve the tables I have drawn up for this purpoſe, and further to approximate to a true theory of the gyration of this planet.

Not knowing the exact difference of meridians between Greenwich and this place, I have calculated the ſpot's appearance for the meridian of Bath. From an eclipſe or two of Jupiter's ſatellites, of which, by the favour of the Rev. Mr. HORNSBY, I have ſeen correſpondent obſervations, I ſuppoſe the difference cannot be much leſs than 9′ weſt of Greenwich; and at the ſame time I join an account of the ſolar eclipſe of the 24th of June 1778, which may be depended upon as a very compleat obſervation, and may ſerve to aſcertain the longitude of this place.

Eclipſe of the ſun obſerved at Bath.

June 24, 1778.

	H.	M.	S.
Beginning by equated or mean time,	3	30	10,7
End, - - -	5	18	7,7

Calculations, or (as the principles on which they are founded are ſtill eſtabliſhed upon a few obſervations only, and require ſome time for mature confirmation) I would rather, if I might be allowed the expreſſion, call them calculated conjectures of the times when the remarkable dark ſpot will be ſeen near the center of the diſk of Mars.

For June, July, and Auguſt, of the year 1781.

	D.	H.	M.	S.
June	28	9	48	39
	29	10	27	10
	30	11	5	42
July	1	11	44	13
	2	12	22	32
	3	13	0	51
	4	13	39	10
	5	14	17	29
	6	14	55	46
	7	15	34	4
July	8	16	13	23
Auguſt	3	8	11	6
	4	8	49	57
	5	9	28	48
	6	10	7	39
	7	10	46	31
	8	11	25	44
	9	12	4	56
	10	12	44	8

I have the honour to be, &c.

Fig. 1.

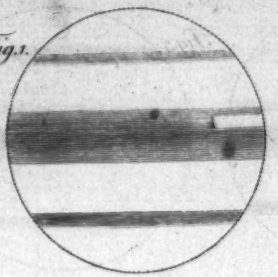


Fig. 2.

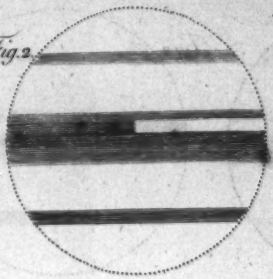


Fig. 5.

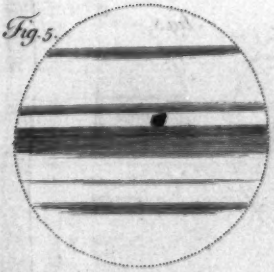


Fig. 6.

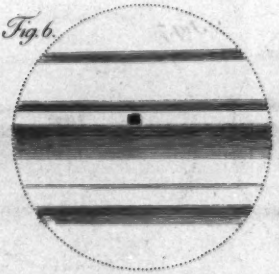


Fig. 7.

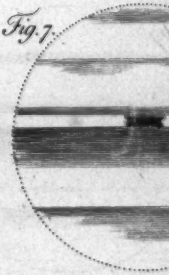


Fig. 10.

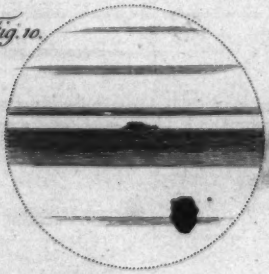


Fig. 11.

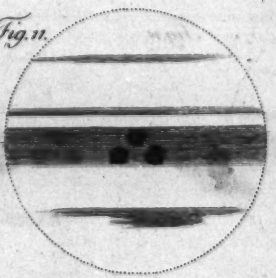


Fig. 3.

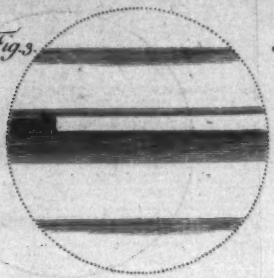


Fig. 4.

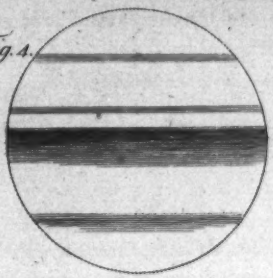


Fig. 8.

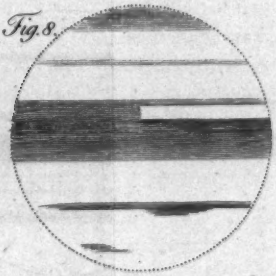


Fig. 9.

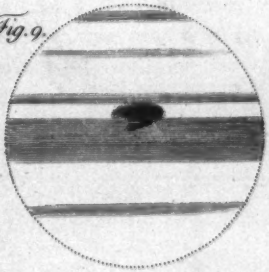


Fig. 12.

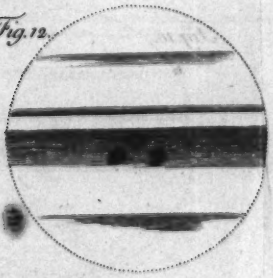


Fig. 13.

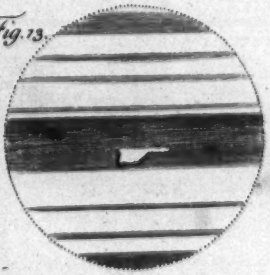


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Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

Fig. 22.

Fig. 24.

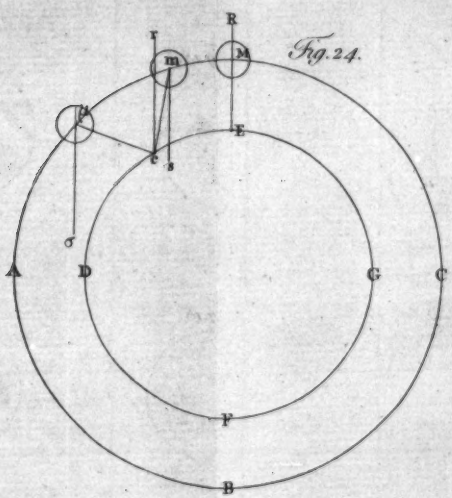

Fig. 23.

XI. *Some Account of the* Termites, *which are found in* Africa *and other hot Climates. In a Letter from Mr.* Henry Smeathman, *of* Clement's Inn, *to Sir* Joseph Banks, *Bart. P. R. S.*

Read February 15, 1781.

SIR, Clement's Inn, Jan. 23, 1781.

OF a great many curious parts of the creation I met with on my travels in that almoſt unknown diſtrict of Africa, called Guinea, the TERMITES, which by moſt travellers have been called WHITE ANTS, ſeemed to me on many accounts, moſt worthy of that exact and minute attention which I have beſtowed upon them.

The amazingly great and ſudden miſchief they frequently do to the property of people in tropical climates, makes them well knownn nd greatly feared by the inhabitants.

The ſize and figure of their buildings have attracted the notice of many travellers, and yet the world has not hitherto been furniſhed with a tolerable deſcription of them, though their contrivance and execution ſcarce fall ſhort of human ingenuity and prudence; but when we come to conſider the wonderful oeconomy of theſe inſects, with the good order of their ſubterraneous cities, they will appear foremoſt on the liſt of the wonders of the creation, as moſt cloſely imitating mankind in provident induſtry and regular government.

You had barely time to see and to admire some of their buildings in New Holland, and have been pleased to say, you think an accurate account of them would meet a favourable reception from the Royal Society. That which I now have the honour to present to you, is accurate and faithful as far as it goes. I have kept as close to my subject as was in my power, without being obscure, or falling short of my intention; and though I have given only the heads of what I could draw from my memorandums on the subject, they will probably be found sufficiently descriptive and historical for the bounds of a letter.

The sagacity of these little insects is so infinitely beyond that of any other animals I have ever heard of, that it is possible the accounts I have here communicated would not appear credible to many, without such vouchers and such corroborating testimony as I am fortunately able to produce, and are now before you. There are also many living witnesses in England to most of the extraordinary relations that I have given, so that I hope to have full credit for such remarks as no one but myself has probably had time and opportunities enough to make, and which are not susceptible of demonstration, except in those places where the insects are found.

Such as they are, I beg leave to lay them, with all diffidence and humility, before you and that illustrious Body of which you are President; and if they should in a small degree meet with approbation, I shall be exceedingly satisfied.

These insects are known by various names. They belong to the TERMES of LINNÆUS, and other systematical naturalists.

By the English, { In the windward parts of Africa they are called *Bagga Bugs*. In the West Indies, *Wood Lice*, *Wood Ants*, or *White Ants*.

By the French, { At Senegal, *Vague-Vagues.*
In the West Indies, *Poux de Bois*, or *Fourmis Blanches.*

By the Bolms, or Sherbro people, in Africa, *Scantz.*

By the Portugueze in the Brazils, *Coupée* or *Cutters*, from their cutting things in pieces.

By this latter name and that of *Piercers* or *Eaters*, and similar terms, they are distinguished in various parts of the tropical regions.

The following are the specific differences, given by Dr. SOLANDER, of such insects of this *genus* as I have observed and collected.

1. TERMES *bellicosus* corpore fusco, alis fusce scentibus: costâ ferrugineâ, stemmatibus subsuperis oculo propinquis, puncto centrali prominulo.

2. TERMES *mordax* nigricans, antennis pedibusque testaceis, alis fuliginosis: areâ marginali dilatatâ: costâ nigricante, stemmatibus inferis oculo approximatis, puncto centrali impresso.

3. TERMES *atrox* nigricans, segmentis abdominalibus margine pallidis, antennis pedibusque testaceis, alis fuliginosis: costâ nigrâ, stemmatibus inferis, puncto centrali impresso.

4. TERMES *destructor* nigricans, abdominis lineâ laterali luteâ, antennis testaceis, alis hyalinis: costâ lutescente, stemmatibus subsuperis, puncto centrali obliterato.

5. TERMES *arborum* corpore testaceo, alis fusce scentibus: costâ lutescente, capite nigricante, stemmatibus inferis oculo approximatis, puncto centrali impresso.

The Termites are represented by LINNÆUS as the greatest plagues of both Indies, and are indeed every way between the

Tropics ſo deemed, from the vaſt damages they cauſe, and the loſſes which are experienced in conſequence of their eating and perforating wooden buildings, utenſils, and furniture, with all kinds of houſehold-ſtuff and merchandize, which are totally deſtroyed by them, if not timely prevented; for nothing leſs hard than metal or ſtone can eſcape their moſt deſtructive jaws.

They have been taken notice of by various travellers in different parts of the torrid zone; and indeed where numerous, as is the caſe in all equinoctial countries and iſlands that are not fully cultivated, if a perſon has not been incited by curioſity to obſerve them, he muſt have been very fortunate who, after a ſhort reſidence, has not been compelled to it for the ſafety of his property.

Theſe inſects have generally obtained the name of Ants, it may be preſumed, from the ſimilarity in their manner of living, which is, in large communities that erect very extraordinary neſts, for the moſt part on the ſurface of the ground, from whence their excurſions are made through ſubterraneous paſſages or covered galleries, which they build whenever neceſſity obliges, or plunder induces, them to march above ground, and at a great diſtance from their habitations carry on a buſineſs of depredation and deſtruction, ſcarce credible but to thoſe who have ſeen it. But notwithſtanding they live in communities, and are like the ants omnivorous; though like them at a certain period they are furniſhed with four wings, and emigrate or colonize at the ſame ſeaſon; they are by no means the ſame kind of inſects, nor does their form correſpond with that of *Ants*, in any one ſtate of their exiſtence, which, like moſt other inſects, is changed ſeveral times.

The Termites reſemble the Ants alſo in their provident and diligent labour, but ſurpaſs them as well as the Bees, Waſps,

Beavers, and all other animals which I have ever heard of, in the arts of building, as much as the Europeans excel the leaſt cultivated ſavages. It is more than probable they excel them as much in ſagacity and the arts of government; it is certain they ſhew more ſubſtantial inſtances of their ingenuity and induſtry than any other animals; and do in fact lay up vaſt magazines of proviſions and other ſtores; a degree of prudence which has of late years been denied, perhaps without reaſon, to the Ants (1).

Such however are the extraordinary circumſtances attending their oeconomy and ſagacity, that it is difficult to determine, whether they are more worthy of the attention of the curious and intelligent part of mankind on theſe accounts, or from the ruinous conſequences of their depredations, which have deſervedly procured them the name of *Fatalis* or *Deſtructor*.

As this is the caſe, it is a little ſurpriſing that an accurate natural hiſtory of theſe wonderful inſects has not been attempted long ſince; eſpecially as, according to BOSMAN (who wrote the beginning of this century) in his deſcription of the Coaſt of Guinea, ſome curious circumſtances relative to them muſt have been known. According to that gentleman, the *King* was ſuppoſed to be as large as a Cray-fiſh (2). This, though a bad compariſon, is pretty near the truth in reſpect to the ſize of the female, who is the *Common Mother* of the community;

(1) Though Ants have no occaſion to lay up ſtores for winter in cold climates, they certainly muſt and do carry great quantities of proviſions into their neſts to feed the young brood; and moſt probably provide ſome before hand for fear of accidents, which might be fatal to the young ones, who, like all inſects in the caterpillar ſtate, are very voracious, and cannot bear diſappointments of long duration.

(2) BOSMAN's Guinea, p. 260.

and, according to the mode we have adopted from time immemorial in ſpeaking of Ants and Bees, the QUEEN.

Theſe communities conſiſt of one *male* and one *female* (who are generally the *common parents* of the whole, or greater part, of the reſt), and of three orders of inſects, apparently of very different ſpecies, but really the ſame, which together compoſe great commonwealths, or rather monarchies, if I may be allowed the term.

The great LINNÆUS, having ſeen or heard of but two of theſe orders, has claſſed the genus erroneouſly; for he has placed it among the *Aptera*, or inſects without wings; whereas the chief order, that is to ſay, the inſect in its perfect ſtate, having four wings without any ſting, it belongs to the *Neuroptera*; in which claſs it will conſtitute a new genus of many ſpecies(3).

The different ſpecies of this genus reſemble each other in form, in their manner of living, and in their good and bad qualities: but differ as much as birds in the manner of building their habitations or neſts, and in the choice of the materials of which they compoſe them.

There are ſome ſpecies which build upon the ſurface of the ground, or part above and part beneath, and one or two ſpecies, perhaps more, that build on the ſtems or branches of trees, ſometimes aloft at a vaſt height.

(3) I have no doubt, from the account and figures given of the European Termes Pulſatorius, or Death Watch, by the illuſtrious BARON DE GEER, in his ſeventh volume of *Memoires pour ſervir à l'Hiſtoire des Inſectes*, that in their perfect ſtate they have wings, and ſwarm or emigrate, and live in a manner analogous to thoſe of hot climates; for they ſeem to have quite the external form of the exotic Termes, that is to ſay, of the firſt and third order. DE GEER, Memoires, tom. VII. p. 45. pl. IV. fig. 1, 2, 3, & 4.

Of

Of every ſpecies there are three orders; firſt, the working inſects, which, for brevity, I ſhall generally call *labourers*; next the fighting ones, or *ſoldiers*, which do no kind of labour; and, laſt of all, the winged ones, or *perfect inſects*, which are male and female, and capable of propagation. Theſe might very appoſitely be called the *nobility* or *gentry*, for they neither labour, or toil, or fight, being quite incapable of either, and almoſt of ſelf-defence. Theſe only are capable of being elected kings or queens; and nature has ſo ordered it, that they emigrate within a few weeks after they are elevated to this ſtate, and either eſtabliſh new kingdoms, or periſh within a day or two.

The *Termes bellicoſus* being the largeſt ſpecies is moſt remarkable and beſt known on the Coaſt of Africa. It erects immenſe buildings of well-tempered clay or earth, which are contrived and finiſhed with ſuch art and ingenuity, that we are at a loſs to ſay, whether they are moſt to be admired on that account, or for their enormous magnitude and ſolidity. It is from the two lower orders of this, or a ſimilar ſpecies, that LINNÆUS ſeems to have taken his deſcription of the *Termes Fatalis*; and moſt of the accounts brought home from Africa or Aſia of the white Ants are alſo taken from a ſpecies that are ſo much alike in external habit and ſize, and build ſo much in their manner, that one may almoſt venture to pronounce them mere variations of the ſame ſpecies.

The reaſon that the larger Termites have been moſt remarked is obvious; they not only build larger and more curious neſts, but are alſo more numerous, and do infinitely more miſchief to mankind. When theſe inſects attack ſuch things as we would not wiſh to have injured, we muſt conſider them as moſt pernicious; but when they are employed in deſtroying decayed trees

and ſubſtances which only incumber the ſurface of the earth, they may be juſtly ſuppoſed very uſeful, and for the reaſon tha they are in one ſenſe moſt pernicious, they are in the other moſt uſeful. In this reſpect they reſemble very much the common Flies, which are regarded by mankind in general as noxious, and at beſt as uſeleſs beings in the creation; but this is certainly for want of conſideration. There are not probably in all nature animals of more importance, and it would not be difficult to prove, that we ſhould feel the want of one or two ſpecies of large quadrupeds, much leſs than of one or two ſpecies of theſe deſpicable-looking inſects. Mankind in general are ſenſible that nothing is more diſagreeable, or more peſtiferous, than putrid ſubſtances; and it is apparent to all who have made obſervation, that thoſe little inſects contribute more to the quick diſſolution and diſperſion of putreſcent matter than any other. They are ſo neceſſary in all hot climates, that even in the open fields a dead animal or ſmall putrid ſubſtance cannot be laid upon the ground two minutes before it will be covered with Flies and their Maggots, which inſtantly entering quickly devour one part, and perforating the reſt in various directions, expoſe the whole to be much ſooner diſſipated by the elements. Thus it is with the Termites; the rapid vegetation in hot climates, of which no idea can be formed by any thing to be ſeen in this, is equalled by as great a degree of deſtruction from natural as well as accidental cauſes(4). It ſeems apparent, that when any thing whatever is arrived at its laſt degree of perfection, the Creator has decreed it ſhall

(4) The Guinea graſs, which is ſo well known and ſo much eſteemed by our planters in the Weſt Indies, grows in Africa thirteen feet high upon an average, which height it attains in about five or ſix months; and the growth of many other plants is as quick.

be

be totally deſtroyed as ſoon as poſſible, that the face of nature may be ſpeedily adorned with freſh productions in the bloom of ſpring or the pride of ſummer: ſo when trees, and even woods, are in part deſtroyed by tornadoes or fire, it is wonderful to obſerve, how many agents are employed in haſtening the total diſſolution of the reſt (5); but in the hot climates there are none ſo expert, or who do their buſineſs ſo expeditiouſly and effectually, as theſe inſects, who in a few weeks deſtroy and carry away the bodies of large trees, without leaving a particle behind, thus clearing the place for other vegetables, which ſoon fill up every vacancy; and in places, where two or three years before there has been a populous town, if the inhabitants, as is frequently the caſe, have choſen to abandon it, there ſhall be a very thick wood, and not the veſtige of a poſt to be ſeen, unleſs the wood has been of a ſpecies which, from its hardneſs, is called *iron wood*.

My general account of the Termites is taken from obſervations made on the *Termes bellicoſus*, to which I was induced by the greater facility and certainty with which they could be made.

The neſts of this ſpecies are ſo numerous all over the iſland of Bananas, and the adjacent continent of Africa, that it is ſcarce poſſible to ſtand upon any open place, ſuch as a rice plantation, or other clear ſpot, where one of theſe buildings is not be ſeen within fifty paces, and frequently two or three are to be ſeen almoſt cloſe to each other. In ſome parts near Senegal, as mentioned by Monſ. ADANSON, their number, magnitude, and cloſeneſs of ſituation, make them appear like the villages of the natives (6): and you have yourſelf ſeen them perhaps ſtill more numerous, though not ſo large, in New Holland. Theſe

(5) See STILLINGFLEET's Tracts.

(6) "But of all the extraordinary things I obſerved, nothing ſtruck me more than certain eminences, which, by their height and regularity, made me take "them

These buildings are usually termed hills, by natives as well as strangers, from their outward appearance, which is that of little hills more or less conical, generally pretty much in the form of sugar loaves, and about ten or twelve feet in perpendicular height above the common surface of the ground (7) (8) (9), tab. VIII. fig. 1.

These

"them at a distance for an assemblage of negroes huts or a considerable village, "and yet they were only the nests of certain insects. They are round pyramids "from eight to ten feet high, upon nearly the same base, with a smooth surface "of rich clay, excessively hard and well built." ADANSON's Voyage to Senegal, 8vo, p. 153—157. Voyage de Senegal, 4to, p. 83 and 99.

Note. What Mr. ADANSON says of the opening which gives ingress and regress is manifestly a mistake, arising from the natural conclusion that those insects had some way out and in to their nests, without examining where it was. It will appear by this account, that they have many thousand ways out and in, but all subterraneous.

(7) JOBSON, in his History of Gambia, says, "The Ant hills are remarkable "cast up in those parts by Pismires, some of them twenty foot in height, of "compasse to contayne a dozen men, with the heat of the sun baked into that "hardnesse, that we used to hide ourselves in the ragged toppes of them, when "we took up stands to shoot at deere or wild beasts." PURCHAS's Pilgrims, vol. II. p. 1570.

(8) "The Ants make nests of the earth about *twice the height of a man.*" BOSMAN's Description of Guinea, p. 276—493.

(9) The labourers are not quite a quarter of an inch in length; however, for the sake of avoiding fractions, and of comparing them and their buildings with those of mankind more easily, I estimate their length or height so much, and the human standard of length or height, also to avoid fractions, at six feet, which is likewise above the height of men. If then one labourer is = to one-fourth of an inch = to six feet, four labourers are = to one inch in height = 24 feet, which multiplied by 12 inches, gives the comparative height of a foot of their building = 288 feet of the building of men, which multiplied by 10 feet, the supposed average height of one of their nests is = 2880 of our feet, which is 240 feet more than half a mile, or near five times the height of the great pyramid; and, so it

is

Theſe hills continue quite bare until they are ſix or eight feet high; but in time the dead barren clay, of which they are compoſed, becomes fertilized by the genial power of the elements in theſe prolific climates, and the addition of vegetable ſalts and other matters brought by the wind; and in the ſecond or third year, the hillock, if not over-ſhaded by trees, becomes, like the reſt of the earth, almoſt covered with graſs and other plants; and in the dry ſeaſon, when the herbage is burnt up by the rays of the ſun, it is not much unlike a very large hay-cock (10).

Every one of theſe buildings conſiſts of two diſtinct parts, the exterior and the interior.

The exterior is one large ſhell in the manner of a dome, large and ſtrong enough to incloſe and ſhelter the interior from the viciſſitudes of the weather, and the inhabitants from the attacks of natural or accidental enemies. It is always, therefore, much ſtronger than the interior building, which is the habitable part divided with a wonderful kind of regularity and contrivance into an amazing number of apartments for the reſidence of the *king* and *queen*, and the nurſing of their nu-

is proportionably wide at the baſe, a great many times its ſolid contents. If to this compariſon we join that of the time in which the different buildings are erected, and conſider the Termites as raiſing theirs in the courſe of three or four years, the immenſity of their works ſets the boaſted magnitude of the antient wonders of the world in a moſt diminutive point of view, and gives a ſpecimen of induſtry and enterprize as much beyond the pride and ambition of men as St. Paul's Cathedral exceeds an Indian hut.

(10) See a figure of one of thoſe neſts in SALMON's Univerſal Traveller, in the map of Gambia, where it is called a Piſmire Hill: there is alſo a figure of one of the labouring inſects; but as the hill is repreſented below all proportion, and the inſect rather larger than life, it gives no idea of the building. I have not been able to find out from what author SALMON took this figure; and it is the only one I have met with.

merous

merous progeny; or for magazines, which are always found well filled with ſtores and proviſions.

I ſhall forbear at this time entering into a very minute account of the inſide of theſe wonderful buildings, as the bare recital might appear tedious; though I flatter myſelf, that when I have an opportunity of communicating it to the publick at large, the readers will follow me through an exact deſcription of them with pleaſure.

Theſe hills make their firſt appearance above ground by a little turret or two in the ſhape of ſugar loaves, which are run a foot high or more (11). Soon after, at ſome little diſtance, while the former are increaſing in height and ſize, they raiſe others, and ſo go on increaſing the number and widening them at the baſe, till their works below are covered with theſe turrets, which they always raiſe the higheſt and largeſt in the middle, and by filling up the intervals, between each turret, collect them as it were into one dome.

They are not very curious or exact about theſe turrets, except in making them very ſolid and ſtrong, and when by the junction of them the dome is compleated, for which purpoſe the turrets anſwer as ſcaffolds, they take away the middle ones entirely, except the tops (which joined together make the crown of the cupola) and apply the clay to the building of the works within, or to erecting freſh turrets for the purpoſe of raiſing the hillock ſtill higher; ſo that no doubt ſome part of the clay is uſed ſeveral times, like the boards and poſts of a maſon's ſcaffold.

(11) Some of theſe turrets are repreſented in the view of their hills, (tab. VII. fig. 3.). I have ſeen turrets on the ſides of theſe neſts four or five feet high (tab. VII. fig. 2. a. a. a.).

When these hills are at about little more than half their height, it is always the practice of the wild bulls to stand as centinels upon them, while the rest of the herd is ruminating below (tab. VII.). They are sufficiently strong for that purpose, and at their full height answer excellently as places to look out. I have been with four men on the top of one of these hillocks. Whenever word was brought us of a vessel in sight, we immediately ran to some Bugga Bug hill, as they are called, and clambered up to get a good view, for upon the common surface it was seldom possible to see over the grass or plants, which, in spite of monthly brushings, generally prevented all horizontal views at any distance.

The outward shell or dome is not only of use to protect and support the interior buildings from external violence and the heavy rains; but to collect and preserve a regular degree of genial warmth and moisture which seems very necessary for hatching the eggs and cherishing the young ones.

The *royal chamber*, which I call so on account of its being adapted for, and occupied by, the *king* and *queen*, appears to be in the opinion of this little people of the most consequence, being always situated as near the center of the interior building as possible, and generally about the height of the common surface of the ground, at a pace or two from the hillock. It is always nearly in the shape of half an egg or an obtuse oval within, and may be supposed to represent a long oven (tab. VIII. fig. 1. and 2.).

In the infant state of the colony, it is not above an inch or thereabout in length; but in time will be increased to six or eight inches or more in the clear, being always in proportion to the size of the *queen*, who, increasing in bulk as in age, at length requires a chamber of such dimensions.

This

This ſingular part would bear a long deſcription, which I ſhall not trouble you with at preſent, and only obſerve, that its floor is perfectly horizontal; and in large hillocks, ſometimes an inch thick and upward of ſolid clay. The roof alſo, which is one ſolid and well-turned oval arch, is generally of about the ſame ſolidity, but in ſome places it is not a quarter of an inch thick, this is on the ſides where it joins the floor (tab. VIII. fig. 1. a. a.), and where the doors or entrances are made level therewith at pretty equal diſtances from each other (tab. VIII. fig. 2. and 4. b. b.)

Theſe entrances will not admit any animal larger than the ſoldiers or labourers, ſo that the *king*, and the *queen* (who is, at full ſize, a thouſand times the weight of a *king*) can never poſſibly go out.

The royal chamber, if in a large hillock, is ſurrounded by an innumerable quantity of others of different ſizes, ſhapes, and dimenſions; but all of them arched in one way or another, ſometimes circular, and ſometimes elliptical or oval.

Theſe either open into each other or communicate by paſſages as wide, and being always empty are evidently made for the ſoldiers and attendants, of whom it will ſoon appear great numbers are neceſſary, and of courſe always in waiting.

Theſe apartments are joined by the magazines and nurſeries. The former are chambers of clay, and are always well filled with proviſions, which to the naked eye ſeem to conſiſt of the raſpings of wood and plants which the Termites deſtroy, but are found in the microſcope to be principally the gums or inſpiſſated juices of plants. Theſe are thrown together in little maſſes, ſome of which are finer than others, and reſemble the ſugar about preſerved fruits, others are like tears of gum, one quite

quite transparent, another like amber, a third brown, and a fourth quite opaque, as we see often in parcels of ordinary gums.

These magazines are intermixed with the nurseries, which are buildings totally different from the rest of the apartments: for these are composed entirely of wooden materials, seemingly joined together with gums. I call them the nurseries because they are invariably occupied by the eggs, and young ones, which appear at first in the shape of labourers, but white as snow. These buildings are exceeding compact, and divided into many very small irregular-shaped chambers, not one of which is to be found of half an inch in width (tab. VIII. fig. 5.). They are placed all round the royal apartments, and as near as possible to them.

When the nest is in the infant state, the nurseries are close to the royal chamber; but as in process of time the queen enlarges, it is necessary to enlarge the chamber for her accommodation; and as she then lays a greater number of eggs, and requires a greater number of attendants, so it is necessary to enlarge and encrease the number of the adjacent apartments; for which purpose the small nurseries which are first built are taken to pieces, rebuilt a little farther off a size bigger, and the number of them encreased at the same time.

Thus they continually enlarge their apartments, pull down, repair, or rebuild, according to their wants, with a degree of sagacity, regularity, and foresight, not even imitated by any other kind of animals or insects that I have yet heard of.

There is one remarkable circumstance attending the nurseries, which I must not at this time omit. They are always found slightly overgrown with *mould* (tab. VIII. fig. 6), and plentifully sprinkled with small white globules about the size of a small pin's head. These at first I took to be the eggs; but,

on bringing them to the microſcope, they evidently appeared to be a ſpecies of muſhroom, in ſhape like our eatable muſhroom in the young ſtate in which it is pickled (tab. VIII. fig. 7.). They appear, when whole, white like ſnow a little thawed and then frozen again, and when bruiſed ſeem compoſed of an infinite number of pellucid particles, approaching to oval forms and difficult to ſeparate; the mouldineſs ſeems likewiſe to be the ſame kind of ſubſtance (12).

The nurſeries are incloſed in chambers of clay, like thoſe which contain the proviſions, but much larger. In the early ſtate of the neſt they are not bigger than an hazel-nut, but in great hills are often as large as a child's head of a year old.

The diſpoſition of the interior parts of theſe hills is pretty much alike, except when ſome inſurmountable obſtacle prevents; for inſtance, when the *king* and *queen* have been firſt lodged near the foot of a rock or of a tree, they are certainly built out of the uſual form, otherwiſe pretty nearly according to the following plan.

The royal chamber is ſituated at about a level with the ſurface of the ground, at an equal diſtance from all the ſides of the building, and directly under the apex of the hill (tab. VII. fig. 2. A. A.).

(12) Mr KONIG, who has examined theſe kind of neſts in the Eaſt Indies, in an Eſſay upon the Termites, read before the Society of Naturaliſts of Berlin, conjectures, that theſe muſhrooms are the food of the young inſects. This ſuppoſition implies, that the old ones have a method of providing for and promoting their growth; a circumſtance which, however ſtrange to thoſe unacquainted with the ſagacity of theſe Inſects, I will venture to ſay, from many other extraordinary facts I have ſeen of them, is not very improbable.

N. B. Mr. KONIG has not diſcovered the magazines of proviſions in the neſts which he opened, as far as I am informed; but I muſt obſerve here, that what I have learned of this gentleman's account was from an extempore tranſlation of the heads of it.

In

It is on all ſides, both above and below, ſurrounded by what I ſhould call the *royal apartments*, which have only labourers and ſoldiers in them, and can be intended for no other purpoſe than for theſe to wait in, either to guard or ſerve their common FATHER and MOTHER, on whoſe ſafety depends the happineſs, and, according to the negroes, even the exiſtence of the whole community.

Theſe apartments compoſe an intricate labyrinth, which extends a foot or more in diameter from the *royal chamber* on every ſide. Here the nurſeries and magazines of proviſions begin, and, being ſeparated by ſmall empty chambers and galleries, which go round them or communicate from one to the other, are continued on all ſides to the outward ſhell, and reach up within it two-thirds or three-fourths of its height, leaving an open area in the middle under the dome, which very much reſembles the nave of an old cathedral: this is ſurrounded by three or four very large Gothic-ſhaped arches, which are ſometimes two or three feet high next the front of the area, but diminiſh very rapidly as they recede from thence like the arches of aiſles in perſpectives, and are ſoon loſt among the innumerable chambers and nurſeries behind them.

All theſe chambers, and the paſſages leading to and from them, being arched, they help to ſupport one another; and while the interior large arches prevent them falling into the center, and keep the area open, the exterior building ſupports them on the outſide.

There are, comparatively ſpeaking, few openings into the great area, and they for the moſt part ſeem intended only to admit that genial warmth into the nurſeries which the dome collects.

The interior building or aſſemblage of nurſeries, chambers, &c. has a flattiſh top or roof without any perforation, which would keep the apartments below dry, in caſe through accident the dome ſhould receive any injury and let in water; and it is never exactly flat and uniform, becauſe they are always adding to it by building more chambers and nurſeries: ſo that the diviſions or columns between the future arched apartments reſemble the pinnacles upon the fronts of ſome old buildings, and demand particular notice as affording one proof that for the moſt part the inſects project their arches, and do not make them, as I imagined for a long time, by excavation (tab. VII. fig. 2. B.).

The area has alſo a flattiſh floor, which lays over the royal chamber, but ſometimes a good height above it, having nurſeries and magazines between (tab. VII. fig. 2. C.). It is likewiſe water-proof, and contrived, as far as I could gueſs, to let the water off, if it ſhould get in, and run over by ſome ſhort way into the ſubterraneous paſſages which run under the loweſt apartments in the hill in various directions, and are of an aſtoniſhing ſize, being wider than the bore of a great cannon. I have a memorandum of one I meaſured, perfectly cylindrical, and thirteen inches in diameter (tab. VII. fig. 2. D. D.).

Theſe ſubterraneous paſſages or galleries are lined very thick with the ſame kind of clay of which the hill is compoſed, and aſcend the inſide of the outward ſhell in a ſpiral manner, and winding round the whole building up to the top interſect each other at different heights, opening either immediately into the dome in various places, and into the interior building, the new turrets, &c. or communicating thereto by other galleries of different bores or diameters, either circular or oval.

From every part of theſe large galleries are various ſmall pipes or galleries leading to different parts of the building.

Under

Under ground there are a great many which lead downward by ſloping deſcents three and four feet perpendicular among the gravel, from whence the labouring Termites cull the finer parts, which, being worked up in their mouths to the conſiſtence of mortar, becomes that ſolid clay or ſtone of which their hills and all their buildings, except their nurſeries, are compoſed.

Other galleries again aſcend and lead out horizontally on every ſide, and are carried under ground near to the ſurface a vaſt diſtance: for if you deſtroy all the neſts within one hundred yards of your houſe, the inhabitants of thoſe which are left unmoleſted farther off will nevertheleſs carry on their ſubterraneous galleries, and invade the goods and merchandizes contained in it by ſap and mine, and do great miſchief, if you are not very circumſpect.

But to return to the cities from whence theſe extraordinary expeditions and operations originate, it ſeems there is a degree of neceſſity for the galleries under the hills being thus large, being the great thoroughfares for all the labourers and ſoldiers going forth or returning upon any buſineſs whatever, whether fetching clay, wood, water, or proviſions; and they are certainly well calculated for the purpoſes to which they are applied, by the ſpiral ſlope which is given them; for if they were perpendicular the labourers would not be able to carry on their building with ſo much facility, as they aſcend a perpendicular with great difficulty, and the ſoldiers can ſcarce do it at all. It is on this account that ſometimes a road like a ledge is made on the perpendicular ſide of any part of the building within their hill, which is flat on the upper ſurface, and half an inch wide, and aſcends gradually like a ſtair-caſe, or like thoſe roads which are cut on the ſides of hills and mountains, that would otherwiſe

wiſe be inacceſſible: by which, and ſimilar contrivances, they travel with great facility to every interior part.

This too is probably the cauſe of their building a kind of bridge of one vaſt arch, which anſwers the purpoſe of a flight of ſtairs from the floor of the area to ſome opening on the ſide of one of the columns which ſupport the great arches, which muſt ſhorten the diſtance exceedingly to thoſe labourers who have the eggs to carry from the royal chamber to ſome of the upper nurſeries, which in ſome hills would be four or five feet in the ſtraighteſt line, and much more if carried through all the winding paſſages which lead through the inner chambers and apartments.

I have a memorandum of one of theſe bridges, half an inch broad, a quarter of an inch thick, and ten inches long, making the ſide of an elliptic arch of proportionable ſize; ſo that it is wonderful it did not fall over or break by its own weight before they got it joined to the ſide of the column above. It was ſtrengthened by a ſmall arch at the bottom, and had a hollow or groove all the length of the upper ſurface, either made purpoſely for the inhabitants to travel over with more ſafety, or elſe, which is not improbable, worn ſo by frequent treading (tab. VII. fig. 2. E. E.).

Thus I have deſcribed, as briefly as the ſubject would admit, and I truſt without exaggeration, thoſe wonderful buildings whoſe ſize and external form have often been mentioned by travellers, but whoſe interior and more curious parts are ſo little known, that I may venture to conſider my account of them as new, which is the only merit it has; for they are conſtructed upon ſo different a plan from any thing elſe upon the earth, and ſo complicated, that I cannot find words equal to

the taſk, and muſt therefore refer to the different figures, which, however extraordinary, ſcarce do juſtice to the ſubjects.

The neſts before deſcribed are ſo remarkable on account of their ſize, that travellers have ſeldom, where they were to be ſeen, taken notice of any other; and have generally, when ſpeaking of white Ants, deſcribed them as inhabitants of thoſe hills. Thoſe, however, which are built by the ſmaller ſpecies of thoſe inſects, are very numerous, and ſome of them exceedingly worth our attention; one ſort in particular, which from their form I have named turret neſts. Theſe are a great deal leſs than the foregoing, and indeed much leſs in proportion to the ſize of the builders; but their external form is more curious, and their ſolidity conſidered they are prodigious buildings for ſo ſmall an animal (13).

Theſe buildings are upright cylinders compoſed of a well-tempered black earth or clay, about three quarters of a yard high, and covered with a roof of the ſame material in the ſhape of a cone, whoſe baſe extends over and hangs down three or four inches wider than the perpendicular ſides of the cylinder, ſo that moſt of them reſemble in ſhape the body of a round wind-mill; but ſome of the roofs have ſo little elevation in the middle, that they are pretty much in the ſhape of the top of a full-grown muſhroom (tab. IX. fig. 1.)

After one of theſe turrets is finiſhed, it is not altered or enlarged; but when no longer capable of containing the community, the foundation of another is laid within a few inches of it. Sometimes, though but rarely, the ſecond is begun before the firſt is finiſhed, and a third before they have completed the

(13) If their height is eſtimated and computed by the ſize of the builders, and compared with ours upon the like ſcale; each of them is four or five times the height of the monument, and a great many times its ſolid contents.

ſecond:

ſecond: thus they will run up five or ſix of theſe turrets at the foot of a tree in the thick woods, and make a moſt ſingular group of buildings (tab. IX.).

The turrets are ſo ſtrongly built, that in caſe of violence they will much ſooner overſet from the foundation, and tear up the gravel and ſolid earth, than break in the middle; and in that caſe the inſects will frequently begin another turret and build it, as it were, through that which is fallen; for they will connect the cylinder below with the ground, and run up a new turret from its upper ſide, ſo that it will ſeem to reſt upon the horizontal cylinder only (tab. IX. fig. 5.).

I have not obſerved any thing elſe about theſe neſts that is remarkable, except the quality of the black brown clay, which is as dark coloured as rich vegetable mould, but burns to an exceeding fine and clear red brick. Within, the whole building is pretty equally divided into innumerable cells of irregular ſhapes; ſometimes they are quadrangular or cubic, and ſometimes pentagonal; but often the angles are ſo ill defined, that each half of a cell will be ſhaped like the inſide of that ſhell which is called the Sea-ear.

Each cell has two or more entrances, and as there are no pipes or galleries, no variety of apartments, no well-turned arches, wooden nurſeries, &c. &c. they do not by any means excite our admiration ſo much as the hill neſts, which are indeed collections of wonders.

There are two ſizes of theſe turret neſts, built by two different ſpecies of Termites. The larger ſpecies, the *Termes atrox*, in its perfect ſtate meaſures one inch and three-tenths from the extremities of the wings on the one ſide to the extremities on the other (tab. X. fig. 14). The leſſer ſpecies, *Termes mordax*, meaſures

measures only eight-tenths of an inch from tip to tip (tab. X. fig. 10.

The next kind of nests, built by another species of this genus, the *Termes arborum*, have very little resemblance to the former in shape or substance. These are generally spherical or oval, and built in trees (14). Sometimes they are seated between the arms and the stems of trees, and very frequently may be seen surrounding the branch of a tree at the height of seventy or eighty feet; and (though but rarely of so large a size) as big as a very great sugar cask (15) (16).

They are composed of small particles of wood and the various gums and juices of trees, combined with, perhaps, those of the animals, and worked by those little industrious creatures into a paste, and so moulded into innumerable little cells of very different and irregular forms, which afford no amusing variety and nothing curious, but the immense quantity of inhabitants, young and old, with which they are at all times crouded; on which account they are sought for in order to feed young fowls, and especially for the rearing of Turkies. These nests are very compact, and so strongly attached to the boughs on which they are fixed, that there is no detaching them but by cutting them in pieces, or sawing off the branch; and they will sustain the force of a tornado as long as the tree on which they are fixed.

(14) The colour of these nests, like that of the roofed turrets, is black, from which, and their irregular surface and orbicular shape, they have been called *Negro Heads* by our first writers on the Caribbee Islands, and by the French, *Tetes des Negres*. See HUNTER's EVELYN's SILVA, p. 17.

I have never been able to discover what author Mr. EVELYN alludes to in this mention of the Negro Heads.

(15) LONG's Jamaica, vol. III. p. 887.

(16) SLOANE's Jamaica, vol. II. p. 321. and sequel.

This ſpecies has the external habit, ſize, and almoſt the colour, of the *Termes atrox* (tab. X. fig. 21.).

There are ſome neſts built in thoſe ſandy plains which we call, after the Spaniards, *Savannas*, that reſemble the hill neſts firſt deſcribed. They are compoſed of a black mud, which is brought from a few inches below the white ſand, and are built in the form of an imperfect cone, or bell-ſhaped, having their tops rounded. Theſe neſts are generally about four or five feet high (*v*). As I ſaw theſe only in paſſing through various Savannahs upon other purſuits, I can ſay very little of their interior parts. They ſeemed to be inhabited by nearly as large inſects, differing very little except in colour, which is lighter than that of the *Termites bellicoſi*.

Having given ſome idea of the neſts, I ſhall beg your patient reading of a more particular account of the inſects themſelves, which will be exceeding neceſſary to a tolerable acquaintance with their oeconomy and management, their manner of building, fighting, and marching, and to a more particular account of their uſes in the creation, and of the vaſt miſchief they cauſe to mankind.

(*v*) "The neſts of Ants are about four feet wide at the baſe, and two high, "of an hemiſpherical form. Though made in looſe ſand, they are ſo hard as "not to be broken without great efforts, and a laden cart could not break "through.—In October and November they add a new ſtory.—The Cochons "de Terre (the Leſſer Anteater of Mr. SLOANE) make holes in theſe nests eight "inches in diameter and ſix deep; *and having deſtroyed the inhabitants, the neſt "is abandoned, but ſometimes the Ants repair it.*" This laſt paragraph ſeems rather founded in conjecture. Voyage au Cap. par M. L'Abbé DE LA CAILLE, p. 305—356.

OVIEDO alſo ſays Ants make hillocks as high as a man.

Among

Among theſe you will find, I muſt confeſs, ſome very extraordinary relations, and many that do not admit a poſſibility of demonſtration; ſuch is the deſcription of the form of an army of the *Termites viarum* marching, and the account of the regularity uſed by the *Termites bellicoſi* in repairing a breach in their hills. But the very ſingular facts, of which you have the proofs before you, are ſufficient I ſhould conceive to procure me belief for the others. Should any perſon doubt, I would wiſh them to conſider, that a ſtudent of nature and nature's laws, in any matter relating thereto, has no temptation to tranſgreſs the bounds of truth. I am very ſenſible, that the works of the creation, and the order thereof, are eſtabliſhed in the higheſt wiſdom; that it is as abſurd to attempt to exaggerate as to detract from them; and can only ſerve to expoſe the ignorance of him who attempts it. Beſides, what I have here advanced muſt be confirmed or contradicted in two or three years, ſince it will doubtleſs be examined into by all the curious who viſit tropical regions.

I have obſerved before, that there are of every ſpecies of *Termites* three orders; of theſe orders the working inſects or labourers are always the moſt numerous; in the *Termes bellicoſus* there ſeems to be at the leaſt one hundred labourers to one of the fighting inſects or ſoldiers. They are in this ſtate about one-fourth of an inch long, and twenty-five of them weigh about a grain; ſo that they are not ſo large as ſome of our ants (tab. X. fig. 6.). From their external habit and fondneſs for wood, they have been very expreſſively called *Wood Lice* by ſome people, and the whole genus has been known by that name, particularly among the French. They reſemble them, it is true, very much at a diſtance, but they run as faſt or faſter than any

other inſects of their ſize, and are inceſſantly buſtling about their affairs (18).

The ſecond order, or ſoldiers, have a very different form from the labourers, and have been by ſome authors ſuppoſed to be the males, and the former neuters; but they are, in fact, the ſame inſects as the foregoing, only they have undergone a change of form, and approached one degree nearer to the perfect ſtate. They are now much larger, being half an inch long, and equal in bulk to fifteen of the labourers (tab. X. fig. 8).

There is now likewiſe a moſt remarkable circumſtance in the form of the head and mouth; for in the former ſtate the mouth is evidently calculated for gnawing and holding bodies; but in this ſtate, the jaws being ſhaped juſt like two very ſharp awls a little jagged (tab. X. fig 9.), they are incapable of any thing but piercing or wounding, for which purpoſes they are very effectual, being as hard as a crab's claw, and placed in a ſtrong horny head, which is of a nut-brown colour, and larger than all the reſt of the body together, which ſeems to labour under great difficulty in carrying it: on which account perhaps the animal is incapable of climbing up perpendicular ſurfaces.

The third order, or the inſect in its perfect ſtate, varies its form ſtill more than ever. The head, thorax, and abdomen, differ almoſt entirely from the ſame parts in the labourers and ſoldiers; and, beſides this, the animal is now furniſhed with four fine large browniſh, tranſparent, wings, with which it is at the time of emigration to wing its way in ſearch of a new ſettle-

(18) ROCHFORT, in the Hiſtory of the Carribee Iſlands, calls them Wood Lice, and mentions the deſtruction they make, &c. p. 149.

ment (19).

ment (19). In ſhort, it differs ſo much from its form and appearance in the other two ſtates, that it has never been ſuppoſed to be the ſame animal, but by thoſe who have ſeen it in the ſame neſt; and ſome of theſe have diſtruſted the evidence of their ſenſes. It was ſo long before I met with them in the neſts myſelf, that I doubted the information which was given me by the natives, that they belonged to the ſame family (tab. X. fig. 1.) Indeed we may open twenty neſts without finding one winged one, for thoſe are to be found only juſt before the commencement of the rainy ſeaſon, when they undergo the laſt change, which is preparative to their colonization. Add to this, they ſometimes abandon an outward part of their building, the community being diminiſhed by ſome accident to me unknown. Sometimes too different ſpecies of the real Ant (Formica) poſſeſs themſelves by force of a lodgement, and ſo are frequently diſlodged from the ſame neſt, and taken for the ſame kind of inſects. This I know is often the caſe with the neſts of the ſmaller ſpecies, which are frequently totally abandoned by the Termites, and completely inhabited by different ſpecies of Ants, Cock-roaches, Scolopendræ, Scorpions, and other vermin, fond of obſcure retreats, that occupy different parts of their roomy buildings; which clearly accounts for your having met with the real Ants in thoſe neſts in New Holland.

(19) "There is a ſort that frequently flies, having red wings. — This flying "ſort flings up the largeſt hills, and is wonderfully nimble and induſtrious." KOLBEIN's Cape of Good Hope, 8vo, vol. II. p. 173.

DAPPER calls the Wood Ants *Acolalon*, and ſays it becomes as big as one's thumb, and then takes wing. Deſcription de l'Afrique, folio, p. 459.

In

In the winged ſtate they have alſo much altered their ſize as well as form. Their bodies now meaſure between ſix and ſeven tenths of an inch in length, and their wings above two inches and a half from tip to tip, and they are equal in bulk to about thirty labourers, or two ſoldiers. They are now alſo furniſhed with two large eyes placed on each ſide of the head, and very conſpicuous; if they have any before, they are not eaſily to be diſtinguiſhed. Probably in the two firſt ſtates, their eyes, if they have any, may be ſmall like thoſe of moles; for as they live like theſe animals always underground, they have as little occaſion for theſe organs, and it is not to be wondered at that we do not diſcover them; but the caſe is much altered when they arrive at the winged ſtate in which they are to roam, though but for a few hours, through the wide air, and explore new and diſtant regions. In this form the animal comes abroad during or ſoon after the firſt tornado, which at the latter end of the dry ſeaſon proclaims the approach of the enſuing rains, and ſeldom waits for a ſecond or third ſhower, if the firſt, as is generally the caſe, happens in the night, and brings much wet after it (20).

The quantities that are to be found the next morning all over the ſurface of the earth, but particularly on the waters, is aſtoniſhing; for their wings are only calculated to carry them

(20) "At night I viſited Mr. HARRISON on board the ſloop; during the time "we had a dreadful tornado, in which a ſort of large flies with long wings came "on board in ſuch prodigious numbers, that flying into the flames of the "candles, the table was ſoon covered with thoſe that burnt their wings; and "others, which were not burnt, as they walked along the table ſhed their wings, "and then were nothing but ſo many perfect large maggots." June 10, 1732. MOOR's Travels, p. 118.

a few hours, and after the rising of the sun not one in a thousand is to be found with four wings, unless the morning continues rainy, when here and there a solitary being is seen winging its way from one place to another, as if solicitous only to avoid its numerous enemies, particularly various species of Ants which are hunting on every spray, on every leaf, and in every possible place, for this unhappy race, of which probably not a pair in many millions get into a place of safety, fulfil the first law of nature, and lay the foundation of a new community.

Not only all kinds of ants, birds, and carnivorous reptiles, as well as insects, are upon the hunt for them, but the inhabitants of many countries, and particularly of that part of Africa where I was, eat them (21) (22) (23) (24) (25).

On

(21) Mr. KONIG, in an Essay upon these Insects, read before the Society of Naturalists of Berlin, says, That, in some parts of the East Indies, the queens are given alive to old men for strengthening the back, and that the natives have a method of catching the winged insects, which he calls females, before the time of emigration. They make two holes in the nest; the one to windward, and the other to leeward. At the leeward opening they place the mouth of a pot, previously rubbed within with an aromatic herb called *Bergera*, which is more valued there than the laurel in Europe. On the windward side they make a fire of kindling materials, which not only drives these insects into the pots, but frequently the hooded snakes also, on which account they are obliged to be cautious in removing them. By this method they catch great quantities, of which they make with flour a variety of pastry, which they can afford to sell very cheap to the poorer ranks of people. Mr. KONIG adds, that in seasons when this kind of food is very plentiful, the too great use of it brings on an epidemic colic and dysentery, which kills in two or three hours.

I have

On the following morning, however, as I have obſerved, they are to be ſeen running upon the ground in chace of each other:

I have not found the Africans ſo ingenious in procuring or dreſſing them. They are content with a very ſmall part of thoſe which, at the time of ſwarming, or rather of emigration, fall into the neighbouring waters, which they ſkim off with calabaſhes, bring large kettles full of them to their habitations, and parch them in iron pots over a gentle fire, ſtirring them about as is uſually done in roaſting coffee. In that ſtate, without ſauce or any other addition, they ſerve them as delicious food; and they put them by hands-full into their mouths, as we do comfits. I have eat them dreſſed this way ſeveral times, and think them both delicate, nouriſhing, and wholeſome; they are ſomething ſweeter, but not ſo fat and cloying as the caterpillar or maggot of the *Palm-tree Snout-beetle*, *Curculio Palmarum*, which is ſerved up at all the luxurious tables of Weſt Indian epicures, particularly of the French, as the greateſt dainty of the Weſtern world.

According to the Baron DE GEER, Mr. SPARRMAN ſays, that the Hottentots eat theſe inſects, and even grow fat upon them; but does not ſay what methods they take to procure or dreſs them. DE GEER, *Memoires des Inſectes*, tom. VII. p. 49.

(22) PISO, DE LAET, MARCGRAVE, and other writers, mention their being an article of diet in different parts of South America.

"Alia præterea datur grandis ſpecies *Tama-iouva* dicta digiti articulum adæquans. Quarum etiam clunes deſſecantur et friguntur pro bono alimento." PISO, Hiſt. Natural. lib. I. p. 9. lib. V. 291.

(23) MARCGR. Hiſt. Nat. 56.

(24) "Denique formicæ hic viſuntur grandiſſimæ, quas indigenæ vulgo comedunt; et in foris venales habent." DE LAET. Americæ Utriuſque Deſcriptio, p. 333.

"Formicis veſcebantur, eaſque ſtudioſe ad victum educabant. Ibid. p. 379."

(25) Sir HANS SLOANE ſays, the ſilk-cotton-tree worm is eſteemed by the Indians and negroes beyond marrow. This worm is no more than a large maggot, being the Caterpillar of a large Capricorn Beetle, or Goat Chafer: the Larva of a pretty large Cerambix (the *Lamia Tribulus* of FABRICIUS) which is alſo brought from Africa, where I have eaten thoſe worms roaſted. This inſect is moſt probably to be found in all countries where the ſilk-cotton-tree (*Bombax*) is indigenous. SLOANE's Jamaica, vol. II. p. 193.

I have

other; ſometimes with one or two wings ſtill hanging to their bodies, which are not only uſeleſs, but ſeem rather cumberſome (26).

The greater part have no wings, but they run exceeding faſt, the males after the females; I have ſometimes remarked two males after one female, contending with great eagerneſs who ſhould win the prize, regardleſs of the innumerable dangers that ſurrounded them.

They are now become from one of the moſt active, induſtrious, and rapacious, from one of the moſt fierce and implacable little animals in the world, the moſt innocent, helpleſs, and cowardly; never making the leaſt reſiſtance to the ſmalleſt Ant. The Ants are to be ſeen on every ſide in infinite numbers, of various ſpecies and ſizes, dragging theſe annual victims of the laws of nature to their different neſts. It is wonderful that a pair ſhould ever eſcape ſo many dangers, and get into a place of ſecurity. Some, however, are ſo fortunate; and being found by ſome of the labouring inſects that are continually running about the ſurface of the ground under their covered galleries, which I ſhall ſhortly deſcribe, are *elected* KINGS and QUEENS of new ſtates; all thoſe who are not ſo elected and preſerved certainly periſh, and moſt probably in the courſe of the following day. The manner in which theſe labourers protect the happy pair from their innumerable enemies, not only on the day of the

I have diſcourſed with ſeveral gentlemen upon the taſte of the white Ants; and on comparing notes we have always agreed, that they are moſt delicious and delicate eating. One gentleman compared them to ſugared marrow, another to ſugared cream and a paſte of ſweet almonds.

(26) LIGON obſerved them, but does not know what they are. LIGON's Barbadoes, p. 63.

maſſacre of almoſt all their race, but for a long time after, will I hope juſtify me in the uſe of the term ELECTION. The little induſtrious creatures immediately encloſe them in a ſmall chamber of clay ſuitable to their ſize, into which at firſt they leave but one ſmall entrance, large enough for themſelves and the ſoldiers to go in and out, but much too little for either of the royal pair to make uſe of; and when neceſſity obliges them to make more entrances, they are never larger; ſo that, of courſe, the *voluntary ſubjects* charge themſelves with the taſk of providing for the offſpring of their ſovereigns as well as to work and to fight for them until they ſhall have raiſed a progeny capable at leaſt of dividing the taſk with them.

It is not until this time, probably, that they conſummate their marriage, as I never ſaw a pair of them joined. The buſineſs of propagation, however, ſoon commences, and the labourers having conſtructed a ſmall wooden nurſery, as before deſcribed, carry the eggs and lodge them there as faſt as they can obtain them from the *queen*.

About this time a moſt extraordinary change begins to take place in the *queen*, to which I know nothing ſimilar, except in the PULEX PENETRANS of LINNÆUS, the JIGGER of the *Weſt Indies*, and in the different ſpecies of COCCUS, COCHINEAL. The abdomen of this female begins gradually to extend and enlarge to ſuch an enormous ſize, that an *old queen* will have it increaſed ſo as to be *fifteen hundred* or *two thouſand times* the bulk of the reſt of her body, and *twenty or thirty thouſand times* the bulk of a labourer, as I have found by carefully weighing and computing the different ſtates (tab. X. fig. 3.). The ſkin between the ſegments of the abdomen extends in every direction; and at laſt the ſegments are removed to half an

inch

inch diſtance from each other, though at firſt the length of the whole abdomen is not half an inch. They preſerve their dark brown colour, and the upper part of the abdomen is marked with a regular ſeries of brown bars from the thorax to the poſterior part of the abdomen, while the intervals between them are covered with a thin, delicate, tranſparent ſkin, and appear of a fine cream colour, a little ſhaded by the dark colour of the inteſtines and watery fluid ſeen here and there beneath. I conjecture the animal is upward of two years old when the abdomen is increaſed to three inches in length: I have ſometimes found them of near twice that ſize. The abdomen is now of an irregular oblong ſhape, being contracted by the muſcles of every ſegment, and is become one vaſt matrix full of eggs, which make long circumvolutions through an innumerable quantity of very minute veſſels that circulate round the inſide in a ſerpentine manner, which would exerciſe the ingenuity of a ſkilful anatomiſt to diſſect and develope. This ſingular matrix is not more remarkable for its amazing extenſion and ſize than for its periſtaltic motion, which reſembles the undulating of waves, and continues inceſſantly without any apparent effort of the animal; ſo that one part or other alternately is riſing and ſinking in perpetual ſucceſſion, and the matrix ſeems never at reſt [27], but is always protruding eggs to the amount (as I have frequently counted in old queens) of ſixty in a minute [28], or eighty thouſand and upward in one day of twenty-four hours [29]. Theſe

(27) "We may obſerve in a *queen*, diſtended with egg, a partition along the "back, and a continued motion from one extreme to the other, much like "that we find in ſilk-worms." Account of Engliſh Ants by GOULD, p. 22.

(28) I cannot poſitively aſſert, that the old queens yield eggs ſo plentifully at all

These eggs are instantly taken from her body by her attendants (of whom there always are, in the royal chamber and the galleries adjacent, a sufficient number in waiting) and carried to the nurseries, which in a great nest may some of them be four or five feet distant in a straight line, and consequently much farther by their winding galleries. Here, after they are hatched, the young are attended and provided with every thing necessary until they are able to shift for themselves, and take their share of the labours of the community. The foregoing, I flatter myself, is an accurate description and account of the *Termes bellicosus* or species that builds the large nests in its different states.

Those which build either the roofed turrets or the nests in the trees, seem in most instances to have a strong resemblance to them, both in their form and oeconomy, going through the same changes from the egg to the winged state. The *queens* also increase to a great size when compared with the labourers; but very short of those *queens* before described. The largest are from about an inch to an inch and a half long, and not much thicker than a common quill. There is the same kind of peristaltic motion in the abdomen, but in a much smaller de-

times, but the protruding them being the consequence of the peristaltic motion, it would seem involuntary on their parts, and the number, or nearly so, always indispensable: the astonishing multitudes of inhabitants found in their nests also countenance this opinion strongly.

(99) Since the reading of this paper, Mr. JOHN HUNTER, so celebrated for his great skill and experience in comparative anatomy, has dissected two young queens. He finds the abdomen contains two ovaria, in each of which are many hundred ova-ducts, and in each of these ova-ducts a vast many eggs; so that there seems no doubt of the fact, as the matrix of a *full-grown queen* must be calculated for the production and yielding of a prodigious number of eggs. He has also dissected the kings: The result of these dissections, with some further particulars, will be related in another paper.

gree;

gree; and, as the animal is incapable of moving from her place, the eggs no doubt are carried to the different cells by the labourers, and reared with a care ſimilar to that which is practiſed in the larger neſts.

It is remarkable of all theſe different ſpecies, that the working and the fighting inſects never expoſe themſelves to the open air; but either travel under ground, or within ſuch trees and ſubſtances as they deſtroy, except, indeed, when they cannot proceed by their latent paſſages, and find it convenient or neceſſary to ſearch for plunder above ground. In that caſe they make pipes of that material with which they build their neſts. The larger ſort uſe the red clay; the turret builders uſe the black clay; and thoſe which build in the trees employ the ſame ligneous ſubſtances of which their neſts are compoſed (30) (31) (32).

With

(30) "Small birds, fowls, Lizards, and other reptiles, ſearch for them as the "moſt delicious morſels; therefore they never go abroad but under their covered "ways." DU TERTRE, quarto, vol. II. p. 345.

(31) "The earth hereabouts was all filled with a ſpecies of a white Ant, called "Vag Vague, different from that which I have elſewhere deſcribed. This, "inſtead of raiſing pyramids, continues buried under ground, and never makes "itſelf known but by ſmall cylindrical galleries of the thickneſs of a gooſe quill, "which it erects againſt the ſeveral bodies it deſigns to attack. Theſe galleries "are formed of earth with infinite delicacy of workmanſhip. The Vag Vagues "make uſe of them as of covert-ways, to work without being ſeen; and what-"ever they faſten themſelves to, whether it be leather, cloth, linen, books, or "wood, it is ſurely gnawed and conſumed. I ſhould have thought myſelf pretty "well off, had they only attacked the reeds of my hut; but they pierced "through a trunk which ſtood on treſtles a foot above the ground, and gnawed "moſt of my book." ADANSON's Voyage to Guinea, 179—337.

N. B. Mr. ADANSON is certainly miſtaken when he ſays, "They never make "themſelves known but by their covered ways, and is the only one whom I have "met

With these materials they completely line most of the roads leading from their nests into the various parts of the country, and travel out and home with the utmost security in all kinds of weather. If they meet a rock or any other obstruction, they will make their way upon the surface; and for that purpose erect a covered way or arch, still of the same materials, continuing it with many windings and ramifications through large groves; having, where it is possible, subterranean pipes running parallel with them, into which they sink and save themselves, if their galleries above ground are destroyed by any violence, or the tread of men or animals alarms them. When one chances by accident to enter any solitary grove, where the ground is pretty well covered with their arched galleries, they give the alarm by loud hissings, which we hear distinctly at every step we make; soon after which we may examine their galleries in vain for the insects, but find little holes, just large enough for them, by which they have made their escape into their subterraneous roads. These galleries are large enough for them to pass and repass so as to prevent any stoppages (though there are always numerous passengers) and shelter them equally from light and

" met with who has been attacked while living by the *white Ants*." I have some doubt, that, although the approaches of the *Termites* were carried up to his bed, the bites he received were from *real Ants*, of which there are some scarce visible which are very numerous and produce great pain; whereas the bite of the *Termes* lets out much blood, and shews not the least symptom of venom. See DU TERTRE's Antilles, vol. II. p. 344. and Descript. de l'Afrique, par LABAT, tom. III. p. 298.

(32) See SLOANE, LIGON, LINNÆUS (Termes Fatalis), FORSKAL (Termes Arda), and the various voyages to Africa and both Indies.

air, as well as from their enemies, of which the ants, being the moſt numerous, are the moſt formidable.

The *Termites*, except their heads, are exceeding ſoft, and covered with a very thin and delicate ſkin; being blind, they are no match on open ground for the ants, who can ſee, and are all of them covered with a ſtrong horny ſhell not eaſily pierced, and are of diſpoſitions bold, active, and rapacious. Whenever the Termites are diſlodged from their covered ways, the various ſpecies of the former, who probably are as numerous above ground as the latter are in their ſubterraneous paſſages, inſtantly ſeize and drag them away to their neſts, to feed the young brood (33) (34) (35). The Termites are therefore exceeding ſolicitous

(33) Sir HANS SLOANE was certainly miſtaken in his account of the Wood Ants; it is utterly improbable that they ſhould go into the neſts of the red Ants and kill them. It is moſt probable, the error has ariſen from Sir HANS's having confounded the two genera of inſects the *Formica* and *Termes* together, which made him never ſpeak of them with preciſion. The reverſe of his account is moſt likely, which is, that the *Formicæ* will follow their plunder into the neſts of the *Termites* and deſtroy them; for the latter always keep within their neſts or covered ways, avoiding all communications with other inſects and animals, and never meddling with them but when dead; whereas the *Formicæ* ramble about every where, and enter every cranny and hole that is large enough, and attack not only inſects and reptiles but even large animals. See SLOANE's Voyage to Jamaica, vol. II. p. 221, 222. tab. 238. *Hiſt. de l'Academie Royale des Sciences*, 1701, p. 16. *Fourmis de Viſite*.

(34) LIGON mentions another *ſort* of *Anti*, and deſcribes the galleries of the *Termites*. LIGON's Barbadoes, p. 64, 65.

(35) MERIAN ſays, the *Ants* make neſts above eight feet high, by which I apprehend ſhe means the neſts of the *Termites*; but in ſpeaking of the manners of the inſects ſhe certainly means ſome ſpecies of the *Formica*. Thoſe which are deſcribed as ſtripping the trees are a ſpecies called, in Tobago, *Para-ſol-Ants*, becauſe they cut out of the leaves of certain trees and plants pieces almoſt circular, and

ſolicitous about the preſerving their covered ways in good repair; and if you demoliſh one of them, for a few inches in length, it is wonderful how ſoon they rebuild it. At firſt in their hurry they get into the open part an inch or two, but ſtop ſo ſuddenly that it is very apparent they are ſurprized: for though ſome run ſtraight on, and get under the arch as ſpeedily as poſſible in the further part, moſt of them run as faſt back, and very few will venture through that part of the track which is left uncovered. In a few minutes you will perceive them rebuilding the arch, and by the next morning they will have reſtored their gallery for three or four yards in length, if ſo much has been ruined; and upon opening it again will be found as numerous as ever, under it, paſſing both ways. If you continue to deſtroy it ſeveral times, they will at length ſeem to give up the point, and build another in a different direction; but, if the old one led to ſome favourite plunder, in a few days will rebuild it again; and, unleſs you deſtroy their neſt, never totally abandon their gallery.

The *Termites arborum*, thoſe which build in trees, frequently eſtabliſh their neſts within the roofs and other parts of houſes, to which they do conſiderable damage, if not timely extirpated.

The large ſpecies are, however, not only much more deſtructive, but more difficult to be guarded againſt, ſince they make their approaches chiefly under ground, deſcending below the foundations of houſes and ſtores at ſeveral feet from the ſurface, and riſing again either in the floors, or entering at the

and are to be ſeen all the year round travelling from the plants along their road to the neſt, with each one of theſe circular pieces of leaves in their jaws, which, from their ſhape and colour, give a very good idea of people walking with paraſols (umbrellas). MERIAN, *Inſectes de Surinam*, p. 18.

bottoms

bottoms of the posts, of which the sides of the buildings are composed, bore quite through them, following the course of the fibres to the top, or making lateral perforations and cavities here and there as they proceed.

While some are employed in gutting the posts, others ascend from them, entering a rafter or some other part of the roof. If they once find the thatch, which seems to be a favourite food, they soon bring up wet clay, and build their pipes or galleries through the roof in various directions, as long as it will support them; sometimes eating the palm-tree leaves and branches of which it is composed, and, perhaps (for variety seems very pleasing to them) the rattan or other running plant which is used as a cord to tye the various parts of the roof together, and that to the posts which support it: thus, with the assistance of the rats, who during the rainy season are apt to shelter themselves there, and to burrow through it, they very soon ruin the house by weakening the fastenings and exposing it to the wet. In the mean time the posts will be perforated in every direction as full of holes as that timber in the bottoms of ships which has been bored by the worms; the fibrous and knotty parts, which are the hardest, being left to the last (36).

They

(36) The sea worms, so pernicious to our shipping, appear to have the same office allotted them in the waters which the Termites have on the land. They will appear, on a very little consideration, to be most important beings in the great chain of creation, and pleasing demonstrations of that infinitely wise and gracious Power which formed, and still preserves, the whole in such wonderful order and beauty: for if it was not for the rapacity of these and such animals, tropical rivers, and indeed the ocean itself, would be choked with the bodies of trees which are annually carried down by the rapid torrents, as many of them would last for ages, and probably be productive of evils, of which, happily,

They ſometimes, in carrying on this buſineſs, find, I will not pretend to ſay how, that the poſt has ſome weight to ſupport, and then if it is a convenient track to the roof, or is itſelf a kind of wood agreeable to them, they bring their mortar, and fill all or moſt of the cavities, leaving the neceſſary roads through it, and as faſt as they take away the wood replace the vacancy with that material; which being worked together by them cloſer and more compactly than human ſtrength or art could ram it, when the houſe is pulled to pieces, in order to examine if any of the poſts are fit to be uſed again, thoſe of the ſofter kinds are often found reduced almoſt to a ſhell, and all or a greater part transformed from wood to clay as ſolid and as hard as many kinds of free-ſtone uſed for building in England. It is much the ſame when the *Termites bellicoſi* get into a cheſt or trunk containing cloaths and other things; if the weight

we cannot in the preſent harmonious ſtate of things form any idea *; whereas now being conſumed by theſe animals, they are more eaſily broken in pieces by the waves; and the fragments which are not devoured become ſpecifically lighter, and are conſequently more readily and more effectually thrown on ſhore, where the ſun, wind, inſects, and various other inſtruments, ſpeedily promote their entire diſſolution, and reſtore the conſtituent particles to that

——— "Mighty hand,
"Which, ever buſy, wheels the ſilent ſpheres;
"Works in the ſecret deep; ſhoots, ſteaming, thence
"The fair profuſion that o'erſpreads the ſpring:
"Flings from the ſun direct the flaming day;
"Feeds every creature; hurls the tempeſt forth;
"And, as on earth this grateful change revolves,
"With tranſport touches all the ſprings of life." THOMSON.

* That wood will endure in water an amazing number of ages, is apparent from the *oak ſtakes* which were driven into the bed of the river Thames on the invaſion of this iſland by *Julius Cæſar*, one of which is to be ſeen in Sir ASHTON LEVER'S Muſeum, and likewiſe from thoſe bodies of trees which are daily found in the bogs and moraſſes of Great Britain and Ireland, which after a duration, the former of eighteen hundred, the latter of upwards of two thouſand years, are found in a perfect ſtate of preſervation.

above

above is great, or they are afraid of Ants or other enemies, and have time, they carry their pipes through, and replace a great part with clay, running their galleries in various directions. The tree Termites, indeed, when they get within a box, often make a neſt there, and being once in poſſeſſion deſtroy it at their leiſure. They did ſo to the pyramidal box which contained my compound microſcope. It was of mahogany, and I had left it in the ſtore of Governor CAMPBELL of Tobago, for a few months, while I made the tour of the Leeward Iſlands. On my return I found theſe inſects had done much miſchief in the ſtore, and, among other things, had taken poſſeſſion of the microſcope, and eaten every thing about it except the glaſs or metal, and the board on which the pedeſtal is fixed, with the drawers under it, and the things incloſed. The cells were built all round the pedeſtal and the tube, and attached to it on every ſide. All the glaſſes which were covered with the wooden ſubſtance of their neſts retained a cloud of a gummy nature upon them that was not eaſily got off, and the lacquer or burniſh with which the braſs work was covered was totally ſpoiled. Another party had taken a liking to the ſtaves of a Madeira caſk, and had let out almoſt a pipe of fine old wine. If the large ſpecies of Africa (the *Termites bellicoſi*) had been ſo long in the uninterrupted poſſeſſion of ſuch a ſtore, they would not have left twenty pounds weight of wood remaining of the whole building, and all that it contained (37).

Theſe

(37) Captain PHILLIP of the navy, who was ſome time at the Brazils in the ſervice of Portugal, gives me the following relation. "An engineer returned "from ſurveying the country, left his trunk on a table: the next morning, not "only all his cloaths were deſtroyed by *white Ants* or *Cutters*, but his papers alſo; "and the latter in ſuch a manner, that there was not a bit left of an inch ſquare.

These insects are not less expeditious in destroying the shelves, wainscotting, and other fixtures of an house, than the house itself. They are for ever piercing and boring in all directions, and sometimes go out of the broadside of one post into that of another joining to it; but they prefer and always destroy the softer substances the first, and are particularly fond of pine and fir-boards, which they excavate and carry away with wonderful dispatch and astonishing cunning: for, except a shelf has something standing upon it, as a book, or any thing else which may tempt them, they will not perforate the surface, but artfully preserve it quite whole, and eat away all the inside, except a few fibres which barely keep the two sides connected together, so that a piece of an inch-board which appears solid to the eye will not weigh much more than two sheets of pasteboard of equal dimensions, after these animals have been a little while in possession of it (38) (39) (40) (41). In short, the Termites are so

"The black lead pencils were likewise so completely destroyed, that the smallest "piece, even of the *black lead* could not be found. The cloaths were not "entirely cut to pieces and carried away, but appeared as if moth-eaten, there "being scarce a piece as large as a shilling that was free from small holes; and "it was further remarkable, that some *silver coin*, which was in the trunk, had a "number of black specks on it, caused by something so corrosive that they could "not easily be rubbed off even with sand." Queen's-square, Wednesday, Jan. 17, 1781.

(38) "The white Ants are transparent as glass, and bite so forcibly, that in "the space of one night alone they can eat their way through a thick wooden "chest of goods, and make it as full of holes, as if it had been shot through "with hail-shot." BOSMAN's Guinea, p. 276, 7. 493.

(39) MOORE's Travels, p. 221.

(40) Voyage de LABAT aux Isles, tom. II. p. 331.

(41) "The wood Ants are the most pernicious of all others, being so very "destructive to timber of most sorts, that, if not prevented, they will in a few "years

ſo inſidious in their attacks, that we cannot be too much on our guard againſt them: they will ſometimes begin and raiſe their works, eſpecially in new houſes, through the floor (42). If you deſtroy the work ſo begun, and make a fire upon the ſpot, the next night they will attempt to riſe through another part; and, if they happen to emerge under a cheſt or trunk early in the night, will pierce the bottom, and deſtroy or ſpoil every thing in it before the morning (43). On theſe accounts we are careful to ſet all our cheſts and boxes upon ſtones or bricks, ſo as to leave the bottoms of ſuch furniture ſome inches above the ground; which not only prevents theſe inſects finding them out ſo readily, but preſerves the bottoms from a corroſive damp which would ſtrike from the earth through, and rot every thing therein: a vaſt deal of vermin alſo would harbour under, ſuch as Cock-roaches, Centipedes, Millepedes, Scorpions, Ants, and various other noiſome inſects.

When the Termites attack trees and branches in the open air, they ſometimes vary their manner of doing it. If a ſtake in a hedge has not taken root and vegetated, it becomes their buſineſs to deſtroy it. If it has a good ſound bark round it, they

" years time deſtroy the whole roof of an houſe, eſpecially if it be of ſoft tim-
" ber. —— They have likewiſe cauſed great loſſes to ſhop-keepers, by boring
" through whole bales of linnen as well as woolen cloths. HUGHES's Barbadoes, p. 93.

(42) The floors are generally made of the ſtone or clay taken from the hills raiſed by theſe inſects, which, being moiſtened with water, and mixed by treading, is beaten level, ſmooth, and compact, with their feet and a kind of hand-bat or beetle.

(43) " One night, in a few hours, they pierced one foot of the table, and
" (having in that manner aſcended) carried their arch acroſs it, and then
" down through the middle of the other foot into the floor, as good luck would
" have it, without doing any damage to the papers left there." KEMPFER Hiſt. Japan, vol. II. p. 127.

will

will enter at the bottom, and eat all but the bark, which will remain, and exhibit the appearance of a ſolid ſtick (which ſome vagrant colony of Ants or other inſects often ſhelter in till the winds diſperſe it); but if they cannot truſt the bark, they cover the whole ſtick with their mortar, and it then looks as if it had been dipped into thick mud that had been dried on. Under this covering they work, leaving no more of the ſtick and bark than is barely ſufficient to ſupport it, and frequently not the ſmalleſt particle, ſo that upon a very ſmall tap with your walking ſtick, the whole ſtake, though apparently as thick as your arm, and five or ſix feet long, loſes its form, and diſappearing like a ſhadow falls in ſmall fragments at your feet. They generally enter the body of a large tree which has fallen through age or been thrown down by violence, on the ſide next the ground, and eat away at their leiſure within the bark, without giving themſelves the trouble either to cover it on the outſide, or to replace the wood which they have removed from within, being ſomehow ſenſible that there is no neceſſity for it. Theſe excavated trees have deceived me two or three times in running: for, attempting to ſtep two or three feet high, I might as well have attempted to ſtep upon a cloud, and have come down with ſuch unexpected violence, that, beſides ſhaking my teeth and bones almoſt to diſlocation, I have been precipitated, head foremoſt, among the neighbouring trees and buſhes. Sometimes, though ſeldom, the animals are known to attack living trees; but not, I apprehend, before ſymptoms of mortification have appeared at the roots, ſince it is evident, as is before obſerved, that theſe inſects are intended in the order of nature to haſten the diſſolution of ſuch trees and vegetables as have arrived at their greateſt maturity and per-

fection, and which would, by a tedious decay, ſerve only to encumber the face of the earth. This purpoſe they anſwer ſo effectually, that nothing periſhable eſcapes them, and it is almoſt impoſſible to leave any thing penetrable upon the ground a long time in ſafety; for the odds are, that, put it where you will abroad, they will find it out before the following morning, and its deſtruction follows very ſoon of courſe. In conſequence of this diſpoſition, the woods never remain long encumbered with the fallen trunks of trees or their branches; and thus it is, as I have before obſerved, the total deſtruction of deſerted towns is ſo effectually completed, that in two or three years a thick wood fills the ſpace; and, unleſs *iron-wood* poſts have been made uſe of, not the leaſt veſtige of an houſe is to be diſcovered.

The firſt object of admiration which ſtrikes one upon opening their hills is the behaviour of the ſoldiers. If you make a breach in a ſlight part of the building, and do it quickly with a ſtrong hoe or pick-axe, in the ſpace of a few ſeconds a ſoldier will run out, and walk about the breach, as if to ſee whether the enemy is gone, or to examine what is the cauſe of the attack. He will ſometimes go in again, as if to give the alarm: but moſt frequently, in a ſhort time, is followed by two or three others, who run as faſt as they can, ſtraggling after one another, and are ſoon followed by a large body who ruſh out as faſt as the breach will permit them, and ſo they proceed, the number increaſing, as long as any one continues battering their building (44). It is not eaſy to deſcribe the rage and fury

(44) "They throw up little hills of ſeven or eight feet high, ſo very full of "holes that they rather ſeem like honey-combs than burrows. Theſe Ant hills "are of a very ſmall circumference in proportion to their height, being ſharp at top, "ſo that to judge by the looks of them one would think the wind could blow them "down.

fury they ſhew. In their hurry they frequently miſs their hold, and tumble down the ſides of the hill, but recover themſelves as quickly as poſſible; and, being blind, bite every thing they run againſt, and thus make a crackling noiſe, while ſome of them beat repeatedly with their forceps upon the building, and make a ſmall vibrating noiſe, ſomething ſhriller and quicker than the ticking of a watch: I could diſtinguiſh this noiſe at three or four feet diſtance, and it continued for a minute at a time, with ſhort intervals. While the attack proceeds they are in the moſt violent buſtle and agitation. If they get hold of any one, they will in an inſtant let out blood enough to weigh againſt their whole body; and if it is the leg they wound, you will ſee the ſtain upon the ſtocking extend an inch in width. They make their hooked jaws meet at the firſt ſtroke, and never quit their hold, but ſuffer themſelves to be pulled away leg by leg, and piece after piece, without the leaſt attempt to eſcape. On the other hand, keep out of their way, and give them no interruption, and they will in leſs than half an hour retire into the neſt, as if they ſuppoſed the wonderful monſter that damaged their caſtle to be gone beyond their reach. Before they are all got in you will ſee the labourers in motion, and haſtening in various directions toward the breach: every one with a burthen of mortar in his mouth ready tempered. This they ſtick upon the breach as faſt as they come up, and do it with ſo much diſpatch and facility, that although there are thouſands, and I may ſay millions, of them, they never ſtop or

" down. I one day attempted to knock off the top of one of them with my cane, " but the ſtroke had no other effect than to bring ſome thouſands of the animals " out of doors, to ſee what was the matter: upon which I took to my heels and " ran away as faſt as I could." SMITH's Voyage to Guinea.

embarraſs

embarraſs one another; and you are moſt agreeably deceived when, after an apparent ſcene of hurry and confuſion, a regular wall ariſes, gradually filling up the chaſm. While they are thus employed, almoſt all the ſoldiers are retired quite out of ſight, except here and there one, who ſaunters about among ſix hundred or a thouſand of the labourers, but never touches the mortar either to lift or carry it; one, in particular, places himſelf cloſe to the wall they are building. This ſoldier will turn himſelf leiſurely on all ſides, and every now and then, at intervals of a minute or two, lift up his head, and with his forceps beat upon the building, and make the vibrating noiſe before mentioned; on which immediately a loud hiſs, which appears to come from all the labourers, iſſues from within ſide the dome and all the ſubterraneous caverns and paſſages: that it does come from the labourers is very evident, for you will ſee them all haſten at every ſuch ſignal, redouble their pace, and work as faſt again.

As the moſt intereſting experiments become dull by repetition or continuance, ſo the uniformity with which this buſineſs is carried on, though ſo very wonderful, at laſt ſatiates the mind. A renewal of the attack, however, inſtantly changes the ſcene, and gratifies our curioſity ſtill more. At every ſtroke we hear a loud hiſs; and on the firſt the labourers run into the many pipes and galleries with which the building is perforated, which they do ſo quickly that they ſeem to vaniſh, for in a few ſeconds all are gone, and the ſoldiers ruſh out as numerous and as vindictive as before (45). On finding no enemy they return again leiſurely into

(45) By the ſoldiers being ſo ready to run out upon the repetition of the attack, it appears, that they but juſt withdraw out of ſight, to leave room for the labourers to proceed without interruption in repairing the breach, and in this inſtance

into the hill, and very ſoon after the labourers appear loaded as at firſt, as active and as aſſiduous, with ſoldiers here and there among them, who act juſt in the ſame manner, one or other of them giving the ſignal to haſten the buſineſs. Thus the pleaſure of ſeeing them come out to fight or to work alternately may be obtained as often as curioſity excites or time permits: and it will certainly be found, that the one order never attempts to fight, or the other to work, let the emergency be ever ſo great.

We meet vaſt obſtacles in examining the interior parts of theſe tumuli. In the firſt place, the works, for inſtance, the apartments which ſurround the royal chamber and the nurſeries, and indeed the whole internal fabric, are moiſt, and conſequently the clay is very brittle: they have alſo ſo cloſe a connexion, that they can only be ſeen as it were by piece-meal; for having a kind of geometrical dependance or abutment againſt each other, the breaking of one arch pulls down two or three. To theſe obſtacles muſt be added the obſtinacy of the ſoldiers, who fight to the very laſt, diſputing every inch of ground ſo well as often to drive away the negroes who are without ſhoes, and make white people bleed plentifully through their ſtockings. Neither can we let a building ſtand ſo as to get a view of the interior parts without interruption, for while the ſoldiers are defending the

inſtance they ſhew more good ſenſe than the bulk of mankind, for, in caſe of a conflagration in a city, the number of people who aſſemble to ſtare is much greater than of thoſe who come to aſſiſt, and the former always interrupt and hinder the latter in their efforts. The ſudden retreat of the labourers, in caſe of an alarm, is alſo a wonderful inſtance of good order and diſcipline, ſeldom ſeen in populous cities, where we frequently find helpleſs people, women, and children, without any ill intention, intermixing in violent tumults and dangerous riots.

out-works, the labourers keep barricadoing all the way againſt us, ſtopping up the different galleries and paſſages which lead to the various apartments, particularly the royal chamber, all the entrances to which they fill up ſo artfully as not to let it be diſtinguiſhable while it remains moiſt; and externally it has no other appearance than that of a ſhapeleſs lump of clay (46). It is, however, eaſily found from its ſituation with reſpect to the other parts of the building, and by the crouds of labourers and ſoldiers which ſurround it, who ſhew their loyalty and fidelity by dying under its walls. The royal chamber in a large neſt is capacious enough to hold many hundreds of the attendants, beſides the royal pair, and you always find it as full of them as it can hold. Theſe faithful ſubjects never abandon their charge even in the laſt diſtreſs; for whenever I took out the royal chamber, and, as I often did, preſerved it for ſome time in a large glaſs bowl, all the attendants continued running in one direction round the king and queen with the utmoſt ſolicitude, ſome of them ſtopping on every circuit at the head of the latter, as if to give her ſomething. When they came to the extremity of the abdomen, they took the eggs from her, and carried them away, and piled them carefully together in ſome part of the chamber, or in the bowl under, or behind any pieces of broken clay which lay moſt convenient for the purpoſe.

(46) In tab. VIII. fig. 2. and 4. the entrances of the royal chamber, now exhibited, are repreſented open. They were all ſhut by the labourers before I had got to it, and were opened ſince I arrived in England. Two or three of them, however, are not quite open in the chamber itſelf, and that next the breach at A, and marked with a croſs ⊕, is ſtill left ſhut, as a ſpecimen of the manner in which they do it. I have alſo more royal chambers and various ſpecimens of the interior buildings, with ſeveral galleries and paſſages, ſhut up while we were attacking the neſt.

Some of these little unhappy creatures would ramble from the chamber, as if to explore the cause of such a horrid ruin and catastrophe to their immense building, as it must appear to them; and, after fruitless endeavours to get over the side of the bowl, return and mix with the croud that continue running round their common parents to the last (tab. VIII. fig. 4. B.). Others, placing themselves along her side, get hold of the queen's vast matrix with their jaws, and pull with all their strength so as visibly to lift up the part which they fix at; but, as I never saw any effect from these attempts, I never could determine whether this pulling was with an intention to remove her body, or to stimulate her to move herself, or for any other purpose; but, after many ineffectual tugs, they would desist and join in the croud running round, or assist some of those who are cutting off clay from the external parts of the chamber or some of the fragments and moistening it with the juices of their bodies, to begin to work a thin arched shell over the body of the queen, as if to exclude the air, or to hide her from the observation of some enemy. These, if not interrupted, before the next morning, completely cover her, leaving room enough within for great numbers to run about her.

I do not mention the king in this case, because he is very small in proportion to the queen, not being bigger than thirty of the labourers, so that he generally conceals himself under one side of the abdomen, except when he goes up to the queen's head, which he does now and then, but not so frequently as the rest.

If in your attack on the hill you stop short of the royal chamber, and cut down about half of the building, and leave open some thousands of galleries and chambers, they will all be shut up with thin sheets of clay before the next morning. If even the whole is pulled down, and the different buildings are thrown

in a confused heap of ruins, provided the king and queen are not destroyed or taken away, every interstice between the ruins, at which either cold or wet can possibly enter, will be so covered as to exclude both, and, if the animals are left undisturbed, in about a year they will raise the building to near its pristine size and grandeur.

The marching Termites are not less curious in their order, as far as I have had an opportunity of observing them, than those described before. This species seems much scarcer and larger than the *Termes bellicosus*. I could get no information relative to them from the black people, from which I conjecture they are little known to them: my seeing them was very accidental. One day, having made an excursion with my gun up the river Camerankoes, on my return through the thick forest, whilst I was sauntering very silently in hopes of finding some sport, on a sudden I heard a loud hiss, which, on account of the many serpents in those countries, is a most alarming sound. The next step caused a repetition of the noise, which I soon recognized, and was rather surprised seeing no covered ways or hills. The noise, however, led me a few paces from the path, where, to my great astonishment and pleasure, I saw an army of Termites coming out of a hole in the ground, which could not be above four or five inches wide. They came out in vast numbers, moving forward as fast seemingly as it was possible for them to march. In less than a yard from this place they divided into two streams or columns, composed chiefly of the first order, which I call labourers, twelve or fifteen a-breast, and crouded as close after one another as sheep in a drove, going straight forward without deviating to the right or left. Among these, here and there, one of the soldiers was to be seen, trudging along with them, in the same manner, neither stopping

or

or turning; and as he carried his enormous large head with apparent difficulty, he put me in mind of a very large ox amidst a flock of sheep. While these were bustling along, a great many soldiers were to be seen spread about on both sides of the two lines of march, some a foot or two distant, standing still or sauntering about as if upon the look out least some enemy should suddenly come upon the labourers. But the most extraordinary part of this march was the conduct of some others of the soldiers, who having mounted the plants which grow thinly here and there in the thick shade, had placed themselves upon the points of the leaves, which were elevated ten or fifteen inches above the ground, and hung over the army marching below. Every now and then one or other of them beat with his forceps upon the leaf, and made the same sort of ticking noise which I had so frequently observed to be made by the soldier who acts the part of a surveyor or super-intendant when the labourers are at work repairing a breach made in one of the common hills of the *Termites bellicosi*. This signal among the marching white Ants produced a similar effect; for, whenever it was made, the whole army returned a hiss, and obeyed the signal by increasing their pace with the utmost hurry. The soldiers who had mounted aloft, and gave these signals, sat quite still during the intervals (except making now and then a slight turn of the head) and seemed as solicitous to keep their posts as regular centinels. The two columns of the army joined into one about twelve or fifteen paces from their separation, having in no part been above three yards asunder, and then descended into the earth by two or three holes. They continued marching by me for above an hour that I stood admiring them, and seemed neither to increase or diminish their numbers, the soldiers only excepted, who quitted

quitted the line of march, and placed themſelves at different diſtances on each ſide of the two columns; for they appeared much more numerous before I quitted the ſpot. Not expecting to ſee any change in their march, and being pinched for time, the tide being nearly up, and our departure fixed at high water, I quitted the ſcene with ſome regret, as the obſervation of a day or two might have afforded me the opportunity of exploring the reaſon and neceſſity of their marching with ſuch expedition, as well as of diſcovering their chief ſettlement, which is probably built in the ſame manner as the large hills before deſcribed. If ſo, it may be larger and more curious, as theſe inſects were at leaſt one-third larger than the other ſpecies, and conſequently their buildings muſt be more wonderful if poſſible: thus much is certain, there muſt be ſome fixed place for their king and queen, and the young ones. Of theſe ſpecies I have not ſeen the perfect inſect.

The œconomy of nature is wonderfully diſplayed in a comparative obſervation on the different ſpecies who are calculated to live under ground until they have wings, and this ſpecies which marches in great bodies in open day. The former, in the two firſt ſtates, that is, of labourers and ſoldiers, have no eyes that I could ever diſcover; but when they arrive at the winged or perfect ſtate in which they are to appear abroad, though only for a few hours, and that chiefly in the night, they are furniſhed with two conſpicuous and fine eyes: ſo the *Termes viarum*, or marching Bugga Bugs, being intended to walk in the open air and light, are even in the firſt ſtate furniſhed with eyes proportionably as fine as thoſe which are given to the winged or perfect inſects of the other ſpecies.

I am

I am afraid of encroaching upon your time, which leads me to drop the ſubject for the preſent; but, as my materials are not exhauſted, if theſe ſheets meet with your approbation, it will encourage me to give ſome further particulars, with obſervations and reflections, at a future period.

I have the honour to be, &c.

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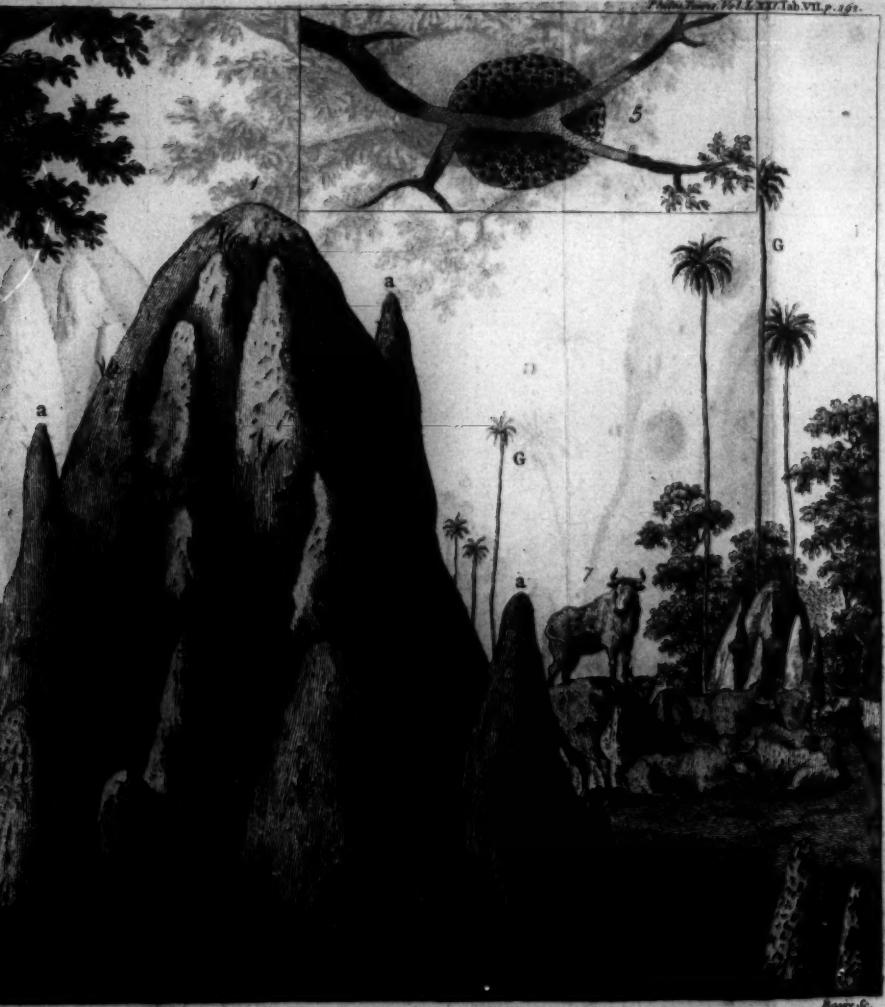

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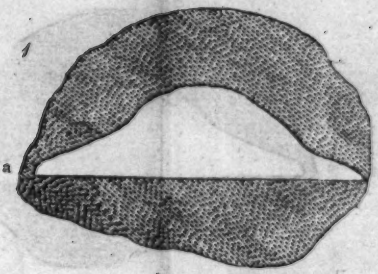

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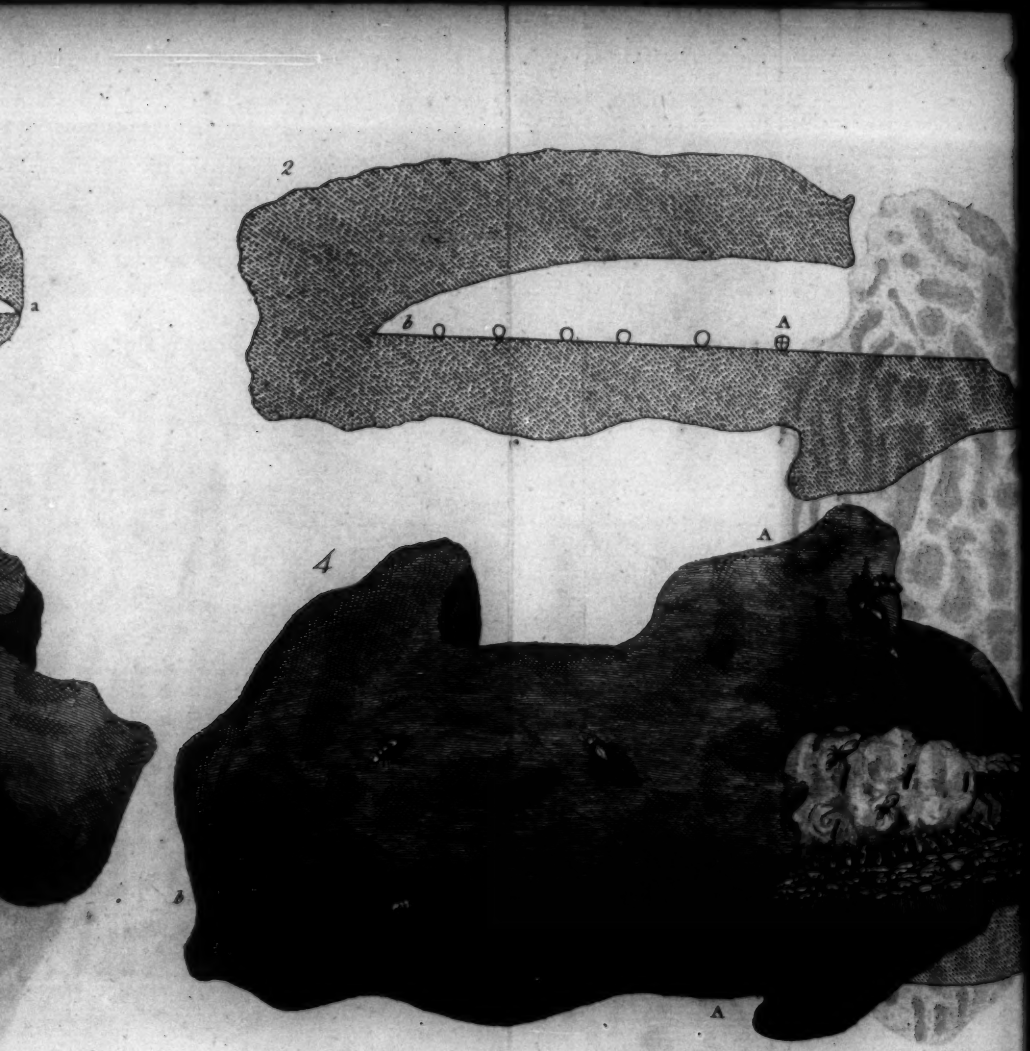
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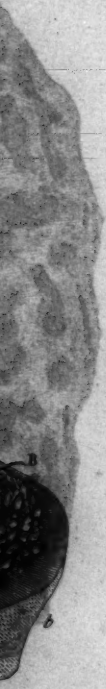

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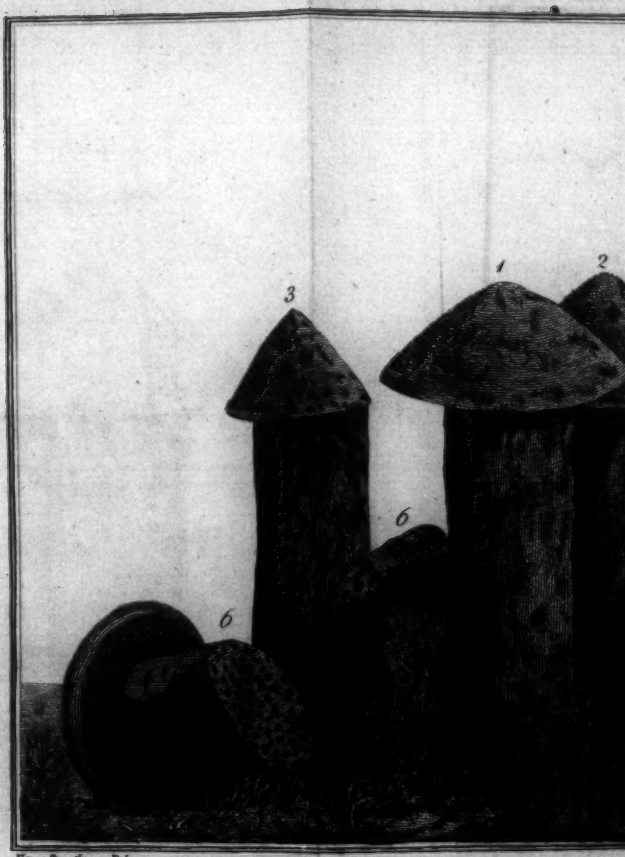

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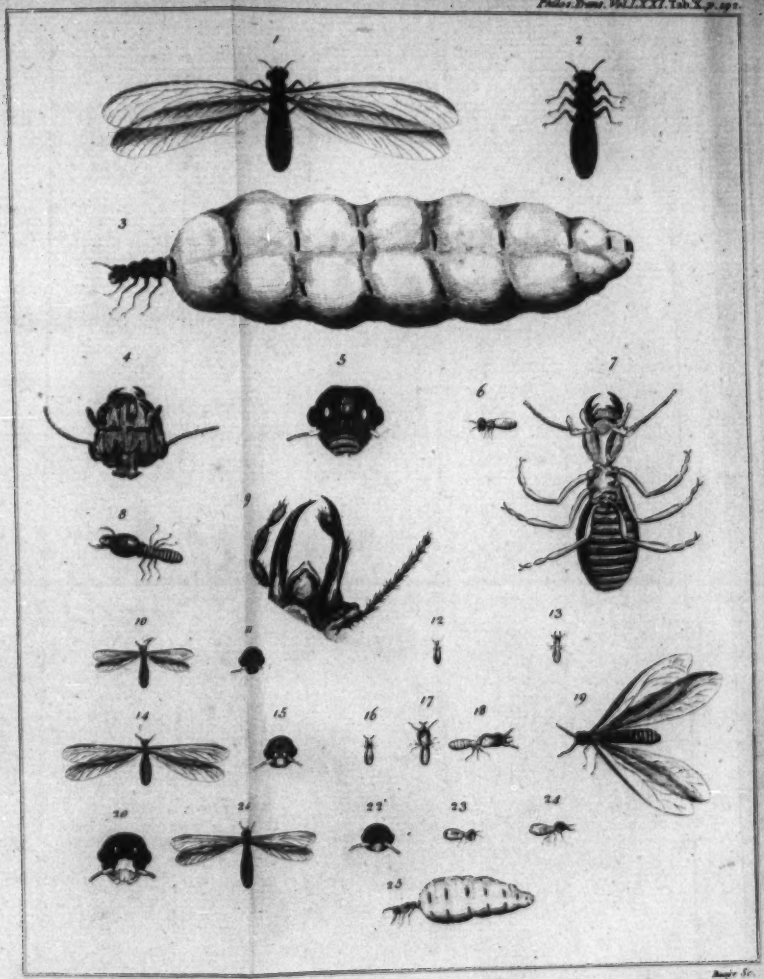

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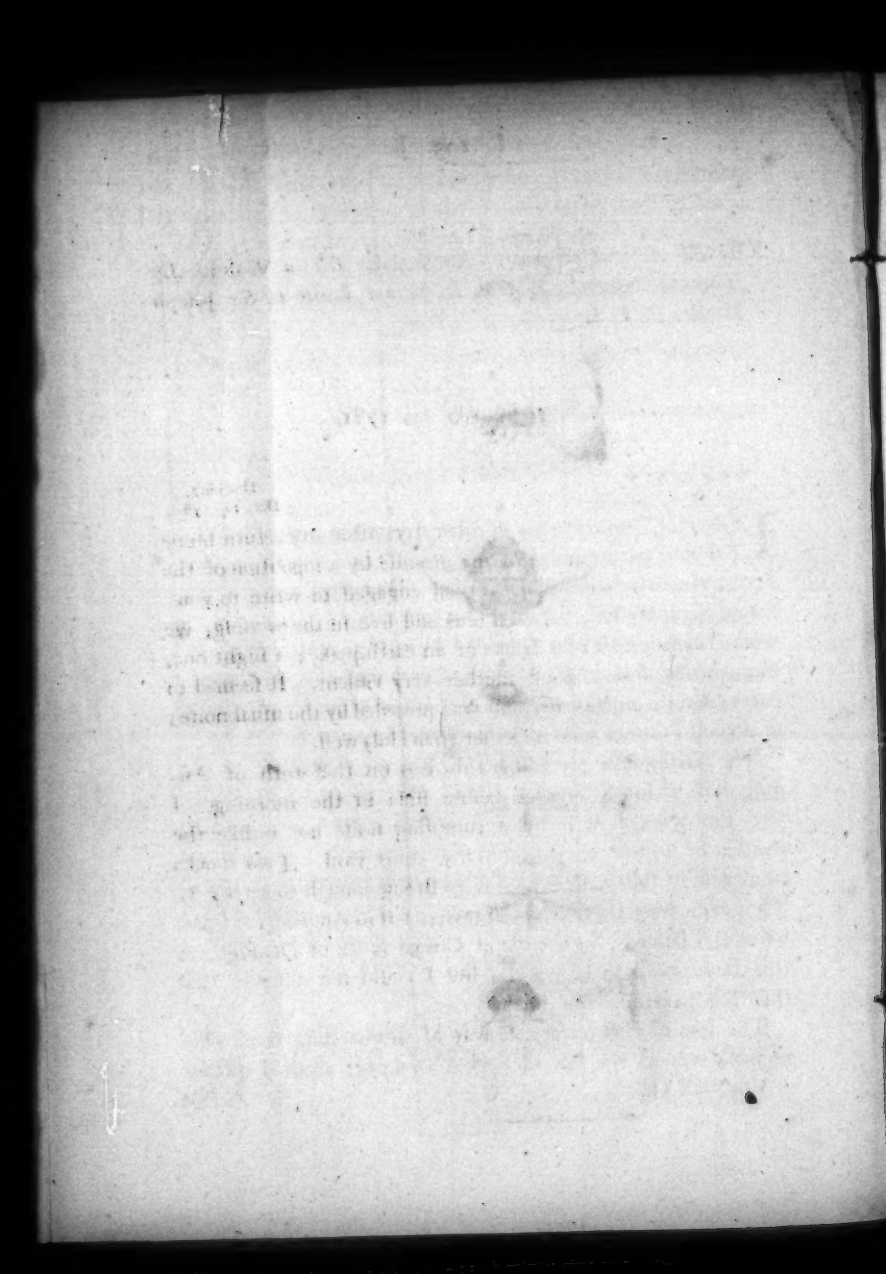

XII. *An Account of ſeveral Earthquakes felt in* Wales. *By* Thomas Pennant, *Eſq. F. R. S. in a Letter to Sir* Joſeph Banks, *P. R. S.*

Read January 25, 1781.

DEAR SIR, Downing, Dec. 12, 1781.

IT is very ſingular, that in three days after my return home I ſhould be reminded of my promiſe by a repetition of the very phenomenon on which I had engaged to write to you: for on Saturday laſt, between four and five in the evening, we were alarmed with two ſhocks of an earthquake; a ſlight one, immediately followed by another very violent. It ſeemed to come from the north-eaſt, and was preceded by the uſual noiſe; at preſent I cannot trace it farther than Holywell.

The earthquake preceding this was on the 29th of Auguſt laſt, about a quarter before nine in the morning. I was fore-warned of it by a rumbling noiſe not unlike the coming of a great waggon into my court-yard. Two ſhocks immediately followed, which were ſtrong enough to terrify us. They came from the north-weſt; were felt in Angleſea, at Caernarvon, Llanrwſt, in the iſle of Clwyd ſouth of Denbigh, at this houſe, and in Holywell; but I could not diſcover that their force extended any farther.

The next in this retrograde way of enumerating theſe phenomena was on the 8th of September 1775, about a quarter

before ten at night, the noiſe was ſuch as preceded the former; and the ſhock ſo violent as to ſhake the bottles and glaſſes on the table round which myſelf and ſome company were ſitting. This ſeemed to come from the eaſt. I ſee in the Gentleman's Magazine of that year, that this ſhock extended to Shropſhire, and quite to Bath, and to Swanſea in South Wales.

The earlieſt earthquake I remember here was on the 10th of April 1750. It has the honour of being recorded in the Philoſophical Tranſactions, therefore I ſhall not trouble you with the repetition of what I have ſaid.

Permit me to obſerve, that I live near a mineral country, in a ſituation between lead mines and coal mines; in a ſort of neutral traſt, about a mile diſtant from the firſt, and half a mile from the laſt. On the ſtricteſt inquiry I cannot diſcover that the miners or colliers were ever ſenſible of the ſhocks under ground: nor have they ever perceived, when the ſhocks in queſtion have happened, any falls of the looſe and ſhattery ſtrata, in which the laſt eſpecially work; yet, at the ſame time, the earthquakes have had violence ſufficient to terrify the inhabitants of the ſurface. Neither were theſe local; for, excepting the firſt, all may be traced to very remote parts. The weather was remarkably ſtill at the time of every earthquake I have felt.

I remain, with true regard, &c.

XIII. *Extract of a Letter from the Right Honourable* Philip *Earl* Stanhope, *F. R. S. to Mr.* James Clow, *Professor of Philosophy in the University of* Glasgow. *Dated* Chevening, February 16, 1777.

Read June 10, 1780.

I HAVE lately made some curious observations concerning the roots of adfected equations, part of which have occurred to Messieurs DANIEL BERNOULLI, EULER, DE LA GRANGE, LAMBERT, and others; but some of them, I believe, are quite new. I will give you one instance of a quadratic equation, as the simplest.

Let the quadratic equation $11xx - 13x + 5 = 0$, be proposed. I say then, that if two recurring series be formed from the fractions $\frac{1+2z}{1-z-zz}$, $\frac{2+3z}{1-z-zz}$, which have a common denominator, and each series of co-efficients, continued both ways (that is, as well before, as after the first term) the fractions formed by dividing each term of the first series by the corresponding term of the second series, *viz.*

&c. $\frac{-11}{-14}, \frac{+7}{+9}, \frac{-4}{-5}, \frac{+3}{+4}, \frac{-1}{-1}, \frac{-3}{-4}, \frac{2}{3}, \frac{1}{2}, \Big| \frac{3}{5}, \frac{4}{7}, \frac{7}{12}, \frac{11}{19}, \frac{18}{31}, \frac{29}{50}$ &c.

will converge in the simplest manner possible; those before the bar, in a retrograde order to the greater root $\frac{15+\sqrt{5}}{22}$; and those after the bar, in a direct order to the smallest root $\frac{15-\sqrt{5}}{22}$; where it is to

be obſerved, that the greater root is affirmative, notwithſtanding the ſign − being prefixed to ſome of the terms, becauſe in each fraction the numerator and the denominator are affected by the ſame ſign, whether + or −.

The chief improvement I have made conſiſts in approximating to two roots at once, by one and the ſame ſeries, continued backwards as well as forwards. I have not time to enlarge upon this ſubject at preſent; but the little I have ſaid will be a ſpecimen of the method to be uſed in higher equations.

XIV. *Extract of Two Meteorological Journals of the Weather observed at* Nain *in* 57° *North Latitude, and at* Okak *in* 57° 20′ *North Latitude, both on the Coast of* Labradore. *Communicated by Mr.* De la Trobe.

Read March 8, 1781.

THERMOMETER AT OKAK.

1779	Highest.	Lowest.	Mean.
August	78,0	37,0	52,0
September	74,0	32,0	45,0
October	45,0	11,0	32,3
November	36,0	15,0	27,3
December	31,0	12,0	12,7
1780			
January	35,0	13,0	15,3
February	33,0	17,0	13,1
March	45,0	14,0	10,0
April	57,0	9,0	29,5
May	55,0	23,0	39,0
June	68,0	33,0	43,6
July	84,0	38,0	52,0

Ther-

	Thermometer at Nain.			Barometer at Nain.		
1778	Higheſt	Loweſt	Mean.	Higheſt.	Loweſt.	Mean.
September	68,0	35,0	45,3	28,4½	27,10	28,1,3
October	60,0	15,0	35,1	28,8	27,4	28,2,0
November	37,0	−5,0	25,4	28,8	27,3	28,0,2
December	28,0	−30,0	1,9	28,7	27,2	28,2,4
1779						
January	13,0	−29,0	−14,3	28,8	26,11	28,1,4
February	13,0	−36,0	−13,2	28,5½	27,5	27,9,9
March	29,0	−20,0	5,0	28,7	27,5	28,2,8
April	51,0	5,0	27,7	28,6½	27,3½	28,1,9
May	63,0	22,0	34,9	28,7½	27,9½	28,2,0
June	71,0	32,0	42,2	28,3	27,8	28,2,5
July	74,0	36,0	48,2	28,5	27,7	28,1,9
Auguſt	78,0	38,0	52,0	28,5	27,8	28,1,5
September	74,0	35,0	45,4	28,6	27,5	28,1,4
October	47,0	14,0	33,6	28,6	27,4½	28,2,5
November	36,0	9,0	27,3	28,5	27,2	28,6,1
December	32,0	−13,0	11,1	28,3½	27,1½	28,3,0
1780						
January	35,0	−16,0	13,4	28,2	26,6	27,6,8
February	32,0	−23,0	9,7	28,5½	26,10	27,9,5
March	39,0	−18,0	10,0	28,8	27,3	28,1,9
April	45,0	4,0	28,2	28,8½	27,7	28,3,7
May	53,0	23,0	37,6	28,6½	27,9	28,3,1
June	61,0	32,0	43,1	28,3	26,11	28,0,5
July	84,0	39,0	52,2	28,1½	27,5	28,1,3
Auguſt	70,0	37,0	50,4	28,3½	27,5	28,1,0

METEOROLOGICAL JOURNAL

KEPT AT THE HOUSE OF

THE ROYAL SOCIETY

BY ORDER OF THE

PRESIDENT AND COUNCIL.

METEOROLOGICAL JOURNAL

for January 1780.

	Time. H.	M.	Therm. without	Therm. within,	Barom. Inches.	Rain. Inch.	Winds. Points.	Str.	Weather.
Jan. 1	8	0	27,0	33.0	30,24		NE	1	Foggy and frosty.
	2	0	31,0	34,0	30,17		SE	1	Foggy.
2	8	0	32,0	33,0	30,35		SE	1	Foggy.
	2	0	36,0	35,0	30,16		SE	1	Foggy.
3	8	0	41,0	37,0	30 09		SE	1	Foggy.
	2	0	43,5	38,5	30,08		SE	1	Foggy and cloudy.
4	8	0	35,0	38,0	30,26		N by W	1	Fair.
	2	0	39,0	39.5	30,34		NE	1	Fine.
5	8	0	31,0	36,0	30,30		WNW	1	Fair.
	2	0	36,0	37,5	30,28		NW	1	Fine.
6	8	0	33,5	35,0	30,00		W	1	Cloudy.
	2	0	37,5	36,5	29,98		SW	1	Foggy and rain.
7	8	0	36,0	36,5	30,14		ENE	1	Cloudy.
	2	0	36,5	38,5	30,20		NE	1	Fine.
8	8	0	26,0	33,0	30,15		NE	1	Fair and frosty.
	2	0	30,5	35,5	30,04		NE	1	Frosty.
9	8	0	22.5	30,0	29,95		NE	1	Frosty.
	2	0	29,5	31,0	29,88		E	1	Fine.
10	8	0	29,0	30,0	29,67		N by E	1	Cloudy.
	2	0	33,0	31,5	29,59		NE	1	Cloudy and snow.
11	8	0	25,0	29,5	29,58		SW	1	Cloudy.
	2	0	32,0	31,5	29,65		NNW	1	Foggy and snow.
12	8	0	24,5	29,5	29,61		NW	1	Fair and frosty.
	2	0	29,0	30,0	29,67		NW	1	Fine.
13	8	0	20,0	27,0	29,94		N by E	1	Fair and frosty.
	2	0	27,0	28,0	29,89		NE	1	Fair and frosty.
14	8	0	20,0	25,0	29,81		NE	1	Fair and frosty.
	2	0	30,0	28.0	29,89		NE	1	Fine.
15	8	0	21,5	24,5	29,45		NE	1	Fair and frosty.
	2	0	33,0	27,5	29,27		NE	1	Foggy.
16	8	0	40,0	32,0	28,70	0,185	SW	2	Fair.
	2	0	47,0	36.5	28,59		SW	2	Rainy.

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	Time.	Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H. M.			Inches.	Inch.	Points.	Str.	
Jan. 17	8 0	40,0	37,0	28,73	0,035	SW	1	Cloudy.
	2 0	46,0	40,5	28,74		W by N	1	Fine.
18	8 0	36,5	38,0	28,92	0,042	NE	1	Cloudy.
	2 0	41,0	39,5	28,97		SW	1	Cloudy.
19	8 0	37,0	39,0	29,14	0,214	NE	1	Cloudy.
	2 0	40,0	37,5	29,28		NE	1	Cloudy.
20	8 0	34,0	38,0	29,37	0,150	N by E	1	Rain.
	2 0	35,5	39,0	29,43		NE	2	Rainy.
21	8 0	33,0	37,0	29,77	0,066	N by E	2	Fair.
	2 0	36,5	38,5	29,86		N by E	2	Fine.
22	8 0	25,0	33,0	30,00		N by W	1	Fair and frosty.
	2 0	32,0	35,0	30,00		N by E	1	Fine.
23	8 0	24,0	31,0	30,00		NE	1	Fair and frosty.
	2 0	28,0	32,5	30,05		NE	1	Foggy.
24	8 0	26,5	31,0	30,01		NW	1	Fair and frosty.
	2 0	34,0	32,5	29,99		NE	1	Fine.
25	8 0	29,0	30,0	30,12		N by E	1	Fair and frosty.
	2 0	35,5	33,5	30,06		N by E	1	Snow.
26	8 0	31,0	31,0	29,95		N by E	2	Cloudy.
	2 0	34,5	32,5	29,95		N by E	1	Cloudy and snow.
27	8 0	28,0	32,0	29,90		N	1	Cloudy with snow.
	2 0	31,0	32,5	29,92		N	1	Cloudy and snow.
28	8 0	30,0	32,5	29,92		E by N	1	Cloudy.
	2 0	32,5	34,0	29,90		E by N	1	Cloudy.
29	8 0	31,5	32,0	29,80		ENE	1	Cloudy.
	2 0	35,0	34,5	29,74		ENE	1	Cloudy.
30	8 0	29,0	31,0	29,66		NE	2	Cloudy.
	2 0	30,0	32,0	29,66		NE	2	Cloudy.
31	8 0	30,5	31,0	29,74		E by S	2	Cloudy.
	2 0	34,0	33,0	29,71		ENE	2	Cloudy.

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	Time.	Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H. M.			Inches.	Inch.	Points.	Str.	
Feb. 1	8 0	30,5	32,0	29,65		NE	2	Cloudy.
	2 0	32,0	33,0	29,62		NE	1	Cloudy.
2	8 0	28,5	31,0	29,48		N by E	1	Fair.
	2 0	33,5	34,5	29,47		NE	1	Fair.
3	8 0	31,5	32,5	29,57		NW	1	Fair.
	2 0	36,5	34,5	29,69		NW	1	Cloudy.
4	8 0	29,0	33,0	29,74		SW	1	Fair.
	2 0	38,5	35,5	29,68		S by W	1	Fine.
5	8 0	30,5	33,0	29,43		NE	1	Fine.
	2 0	35,0	35,0	29,41		SE	1	Fine.
6	8 0	33,0	34,0	29,08	0,210	NE	1	Rainy.
	2 0	36,5	35,0	29,11		WSW	1	Rainy and foggy.
7	8 0	34,0	36,0	29,48	0,034	NW	1	Fair.
	2 0	38,5	38,0	29,68		NW	1	Fine.
8	8 0	32,5	36,0	29,89	0,022	SE	1	Fair.
	2 0	41,0	48,0	29,92		SE	1	Fine.
9	8 0	43,0	39,0	30,00	0,270	S by W	1	Cloudy.
	2 0	50,5	42,0	30,08		S by E	1	Cloudy.
10	8 0	45,5	44,5	30,22	0,015	SW	1	Cloudy.
	2 0	51,5	46,5	30,24		SW	1	Cloudy.
11	8 0	40,0	45,5	30,41		NE	1	Cloudy.
	2 0	44,0	45,5	30,45		ENE	1	Fine.
12	8 0	36,5	42,0	30,47		NE	1	Cloudy.
	2 0	41,0	43,0	30,47		ENE	1	Cloudy.
13	8 0	37,0	40,5	30,48		NE	1	Fair.
	2 0	41,5	42,0	30,52		NE	1	Fair.
14	8 0	34,0	39,5	30,50		N by W	1	Cloudy.
	2 0	43,0	41,5	30,46		N by W	1	Cloudy.
15	8 0	35,5	39,5	30,40		N by W	1	Fair.
	2 0	40,0	40,0	30,39		N by W	1	Cloudy.
16	8 0	37,0	39,0	30,08		NW	1	Fair.
	2 0	45,0	42,0	30,00		NW	1	Fair.

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	Time. H.	Time. M.	Therm. without	Therm. within.	Barom. Inches.	Rain. Inch	Winds. Points.	Winds. Str.	Weather.
Feb. 17	8	0	32,0	38,0	30,19		S by E	1	Foggy.
	2	0	38,5	39,0	30,25		SE	1	Foggy and cloudy.
18	8	0	35,0	38,5	30,06		SW	1	Cloudy.
	2	0	41,0	41,0	29,92		SW	1	Cloudy.
19	8	0	36,0	40,5	30,41	0,030	NE	1	Fine.
	2	0	43,0	42,0	29,49		W	1	Fair.
20	8	0	27,5	37,0	29,56		NW	1	Fine.
	2	0	34,0	37,0	29,57		NNW	1	Snow.
21	8	0	27,5	33,0	29,72		NW	2	Fair.
	2	0	36,0	35,5	29,78		NW	2	Fine.
22	8	0	28,0	32,5	29,86		NW	2	Fine.
	2	0	30,0	37,5	29,94		NW	1	Fine.
23	8	0	28,0	32,5	30,18		NNW	1	Fine.
	2	0	38,0	35,0	30,24		NW	1	Fine.
24	8	0	34,0	34,0	30,23		SSW	1	Cloudy.
	2	0	41,0	36,0	30,27		SW	1	Rainy.
25	8	0	41,0	38,5	30,06	0,015	SW	2	Cloudy.
	2	0	47,0	49,0	29,88		SW	2	Cloudy.
26	8	0	26,5	35,0	29,83	0,128	NW	3	Fine.
	2	0	32,5	35,5	30,08		NE	3	Fine.
27	8	0	34,0	34,5	29,99		SW	2	Snowy.
	2	0	42,0	36,5	29,82		SSW	1	Cloudy.
28	8	0	42,0	40,0	29,92	0,034	WSW	1	Cloudy.
	2	0	53,5	44,5	29,95		WSW	2	Fine.
29	8	0	40,0	40,0	29,91		W by S	1	Fair.
	2	0	50,0	41,0	30,03		SW	1	Fine.

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	Time. H.	M.	Therm. without	Therm. within.	Barom.	Rain.	Winds. Points.	Str.	Weather.
					Inches.	Inch.			
Mar. 1	7	0	34,5	43,0	30,10		W by S	1	Fair.
	2	0	47,0	46,0	30,09		SW	1	Fine.
2	7	0	45,0	45,5	29,78		SW	1	Cloudy.
	2	0	50,0	41,0	29,59		SE	1	Cloudy.
3	7	0	39,0	45,0	29,74		WNW	1	Cloudy.
	2	0	48,5	48,5	29,65		NW	1	Fine.
4	7	0	37,5	43,0	29,91		SW	1	Fair.
	2	0	50,5	46,0	30,05		W by N	1	Fine.
5	7	0	47,0	45,0	30,17	0,071	WSW	2	Fair.
	2	0	55,0	48,5	30,25		WSW	1	Cloudy.
6	7	0	45,0	47,5	30,37		SW	1	Fine.
	2	0	56,0	52,0	30,42		SW	2	Fine.
7	7	0	47,5	51,0	30,36		SW	1	Fair.
	2	0	57,0	53,0	30,39		SW	2	Fine.
8	7	0	48,0	51,0	30,37		SW	1	Cloudy.
	2	0	54,0	55,5	30,35		SW	1	Fair.
9	7	0	44,5	50,0	30,13		SSW	1	Cloudy.
	2	0	50,0	51,5	30,01		SW	1	Fine.
10	7	0	37,0	46,0	30,34		W by S	1	Fair.
	2	0	50,0	48,5	30,45		SW	1	Fine.
11	7	0	35,0	43,0	30,39		SE	1	Fair.
	2	0	50,0	47,0	30,25		SW	1	Fine.
12	7	0	44,0	45,0	29,78		S by W	1	Cloudy.
	2	0	52,0	48,5	29,79		SSW	1	Rainy.
13	7	0	35,0	44,0	30,16	0,072	SW	1	Fine.
	2	0	51,0	47,5	30,15		SW	1	Fine.
14	7	0	44,0	47,0	29,93		SSW	1	Fine.
	2	0	54,5	48,5	29,82		SW	2	Fine.
15	7	0	45,0	49,0	29,52	0,046	W by N	2	Rainy.
	2	0	48,5	50,0	29,58		WNW	2	Fine.
16	7	0	42,0	46,0	29,38	0,227	NW	1	Fine.
	2	0	51,0	50,0	29,67		NW	1	Fine.

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	Time.		Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H.	M.			Inches.	Inch.	Points.	Str.	
Mar. 17	7	0	38,0	36,0	29,99		NW	1	Fine.
	2	0	49,5	56,0	29,42		NW	1	Fine.
18	7	0	50,0	51,0	29,67		NW	2	Cloudy.
	2	0	48,0	51,0	29,43		NW	2	Rainy.
19	7	0	40,0	58,0	29,35	0,360	NW	1	Fine.
	2	0	54,0	50,5	29,47		NW	1	Fine.
20	7	0	47,0	49,5	29,46	0,160	NE	1	Cloudy and rain.
	2	0	59,0	54,0	29,95		NW	1	Cloudy.
21	7	0	50,0	51,0	29,82		NW	1	Cloudy.
	2	0	58,0	54,0	29,78		NW	1	Cloudy.
22	7	0	44,0	50,0	29,83		NW	1	Cloudy.
	2	0	52,0	51,5	29,92		SW	2	Fine.
23	7	0	37,0	45,0	30,28		NW	1	Fine.
	2	0	56,0	46,0	30,27		SW	1	Fine.
24	7	0	35,5	43,5	30,11		E by S	1	Fair.
	2	0	51,5	46,5	30,00		E by N	1	Fine.
25	7	0	43,0	45,5	29,82	0,112	SSE	1	Fine.
	2	0	56,0	49,0	29,97		SE	1	Fine.
26	7	0	46,0	47,0	29,94		S by E	1	Fair.
	2	0	51,5	56,5	29,94		SSE	1	Fair.
27	7	0	52,5	51,5	29,90		SSE	1	Fair.
	2	0	62,5	55,0	29,85		SW	1	Fine.
28	7	0	51,0	54,0	29,62		E by N	1	Fair.
	2	0	56,0	56,5	29,61		SW	1	Rainy.
29	7	0	47,0	51,5	29,84	0,077	S by W	2	Fair.
	2	0	55,0	54,5	29,82		S by W	2	Fair.
30	7	0	51,5	53,5	29,71		SSW	1	Fair.
	2	0	55,0	55,5	29,69		SW	1	Showery with sun-shine.
31	7	0	45,0	52,0	29,63	0,054	SSW	1	Fine.
	2	0	50,0	53,5	29,63		SW	1	Rainy.

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	Time. H.	M.	Therm. without	Therm. within.	Barom Inches	Rain. Inch.	Winds. Points.	Str.	Weather.
Apr. 1	7	0	40,0	48,5	29,88	0,324	N by E	1	Fair.
	2	0	49,0	50,0	29,87		SSE	1	Fine.
2	7	0	44,0	46,0	29,51	0,014	SE	1	Cloudy.
	2	0	49,0	49,5	29,21		SSE	1	Rainy.
3	7	0	41,5	46,5	28,81	0,333	WSW	1	Cloudy.
	2	0	44,0	47,0	28,88		NNW	1	Rainy.
4	7	0	34,0	42,0	29,36	0,010	NNW	1	Fine.
	2	0	44,5	43,5	29,45		NW	2	Fine.
5	7	0	35,5	40,5	29,48	0,016	SW	1	Fine.
	2	0	35,5	41,0	29,50		NNW	1	Snow.
6	7	0	34,0	39,0	29,68	0,177	N by W	1	Fine.
	2	0	45,0	43,0	29,83		NW	1	Fine.
7	7	0	33,0	38,0	29,81	0,010	NE	1	Fair.
	2	0	46,5	42,0	29,72		SE	1	Fine.
8	7	0	34,0	39,0	29,71		NNE	1	Fine.
	2	0	46,5	42,5	29,80		N by W	1	Fair.
9	7	0	40,0	39,0	30,08	0,020	NNE	2	Fine.
	2	0	47,5	41,5	30,12		ENE	1	Fine.
10	7	0	33,5	38,0	30,17		SE	1	Fair.
	2	0	47,0	41,5	30,10		E by N	1	Fair.
11	7	0	41,0	41,0	29,77	0,050	S by E	1	Rainy.
	2	0	46,0	49,0	29,79		SE	1	Rainy.
12	7	0	42,0	43,5	29,50	0,156	NW	1	Fine.
	2	0	51,0	47,0	29,46		W by N	1	Cloudy.
13	7	0	38,0	43,0	29,57	0,250	NNE	2	Fine.
	2	0	57,0	44,5	29,69		NNE	2	Rain.
14	7	0	41,0	42,0	29,72	0,038	NW	2	Fair.
	2	0	46,5	44,5	29,75		NW	2	Fair.
15	7	0	43,5	43,5	29,75		WSW	1	Cloudy.
	2	0	51,5	46,0	29,74		W by N	1	Cloudy.
16	7	0	47,0	45,0	29,62	0,035	NW	2	Fine.
	2	0	55,0	49,0	29,67		WNW	2	Fine.

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	Time.		Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H.	M.			Inches.		Points.	Str.	
Apr. 17	7	0	43,0	46,5	29,38	0,080	WNW	3	Fine.
	2	0	49,0	50,0	29,37		WNW	3	Fine.
18	7	0	41,5	46 5	29,30	0,056	SW	2	Cloudy.
	2	0	48 5	47,5	29,46		WSW	2	Showery.
19	7	0	43,0	44,0	29,72	0,050	N by E	2	Fine.
	2	0	53,0	48,0	29,76		N by E	2	Fair.
20	7	0	42,0	44,5	29,94	0,030	NW	1	Fine.
	2	0	52,0	48,0	30,01		NW	1	Fair.
21	7	0	47,5	48 0	29,91		SSE	1	Fair.
	2	0	52,0	50,0	29,83		SSW	2	Showery.
22	7	0	47,0	50,0	29,70	0,109	SW	1	Cloudy.
	2	0	58,0	53 5	29,71		SW	1	Fine.
23	7	0	47,5	50,0	29,52	0,031	S by W	1	Fine.
	2	0	56,5	54,0	29,47		SSW	2	Showery.
24	7	0	46,5	51,0	29,46	0,047	WSW	2	Fine.
	2	0	54,0	53,5	29,43		SSE	2	Showery.
25	7	0	45,0	50,5	29,51	0,053	S by E	1	Fine.
	2	0	56,5	54,0	29,46		SSW	1	Fine.
26	7	0	45,0	49,0	29,46	0,391	NW	2	Fine.
	2	0	58,0	53,5	29,74		NW	2	Fine.
27	7	0	50,0	50,5	29,50	0,210	SSW	1	Rainy.
	2	0	56,0	54,0	29,44		SSW	1	Rainy.
28	7	0	54,5	55,0	29,83	0,183	SW	1	Cloudy.
	2	0	60,5	59,5	29,85		SW	1	Rainy.
29	7	0	53,0	56,0	29,66	0,066	SW	1	Cloudy.
	2	0	65,5	60,5	29,66		SW	1	Fine.
30	7	0	55,0	58,0	29,71		SSW	1	Cloudy.
	2	0	61,0	65,0	29,73		S by W	1	Fine.

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for May 1780.

	Time.		Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H.	M.			Inches.	Inch.	Points.	Str.	
May 1	7	0	53,0	58,0	29,76	0,067	SSW	1	Cloudy.
	2	0	65,0	62,0	29,79		SW	1	Fine.
2	7	0	52,0	56,0	29,85	0,243	N by W	1	Cloudy.
	2	0	59,5	59,0	30 04		NW	1	Fine.
3	7	0	45 5	51,0	30,26		E by S	1	Cloudy.
	2	0	57,0	55,0	30,26		SE	1	Fine.
4	7	0	48,0	52.5	30,18		WSW	1	Cloudy.
	2	0	64,0	56,5	30,16		SW	1	Fine.
5	7	0	53,0	55,0	29,92		SW	1	Cloudy.
	2	0	59,5	58.0	29,88		SW	1	Cloudy.
6	7	0	52,5	55,0	29,88		WSW	2	Fine.
	2	0	60,0	58,5	29,90		W by N	2	Cloudy.
7	7	0	53,0	55,0	29,94		W by S	1	Cloudy.
	2	0	63,5	59,5	29,94		SW	1	Fair.
8	7	0	52,0	57,0	29,72	0,032	SW	1	Rainy.
	2	0	55,0	57,5	29,58		S by W	2	Rainy.
9	7	0	540	55,0	29,67	0,091	SW	1	Fine.
	2	0	57,0	58,5	29,64		SW	2	Rainy.
10	7	0	53,0	54,5	29,38	0,200	SW	2	Fine.
	2	0	59,0	58,5	29,51		SW	2	Cloudy.
11	7	0	53 0	57.5	29,72		SW	2	Fine.
	2	0	58,0	59,0	29,88		SW	2	Rainy.
12	7	0	50,0	57,0	29,98		SSW	1	Fine.
	2	0	64,0	60,0	29,98		SW	1	Fine.
13	7	0	53,0	55,0	29,75	0,104	SW	1	Fair.
	2	0	63,0	60,5	29 73		SW	2	Fine.
14	7	0	51,5	57,0	29,78		W by S	1	Fine.
	2	0	57,0	58,5	29,71		SSW	1	Fine.
15	7	0	50,0	55,0	29,82	0,015	NW	2	Fine.
	2	0	33,0	68.5	29,94		NW	1	Fine.
16	7	0	54,5	56,5	30,12		NW	1	Fine.
	2	0	66,0	61,0	30,18		SW	1	Fine.

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	Time.		Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H.	M.			inches.	Inch.	Points	Str.	
May 17	7	0	58,5	61,0	30,14		SW	1	Fair.
	2	0	68,0	63,5	30,15		SW	1	Fine.
18	7	0	54,5	60,0	30,15		NW	1	Fine.
	2	0	67,0	62,5	30,17		NW	1	Fine.
19	7	0	57,5	61,5	29,92		SW	1	Cloudy.
	2	0	66,0	62,0	29,90		SW	1	Fair.
20	7	0	46,5	61,0	30,25		NW	1	Fair.
	2	0	61,0	58,5	30,26		NW	1	Fine.
21	7	0	57,0	53,5	29,49		SE	1	Fair.
	2	0	67,0	61,0	30,01		SW	1	Fine.
22	7	0	56,0	58,0	29,61	0,027	SSW	1	Rainy.
	2	0	65,0	61,0	29,60		SW	1	Fair.
23	7	0	55,5	58,5	29,67		SW	2	Cloudy.
	2	0	63,0	65,0	29,72		SW	2	Fine.
24	7	0	53,0	58,5	29,73	0,011	NW	1	Fair.
	2	0	63,5	60,5	30,23		SE	1	Fair.
25	7	0	57,0	59,5	30,21		SW	1	Cloudy.
	2	0	66,5	61,5	30,12		SW	1	Fine.
26	7	0	58,0	61,5	30,14	0,018	SW	1	Rainy.
	2	0	70,0	65,0	30,14		SW	1	Fine.
27	7	0	60,5	64,0	30,28		SW	1	Fine.
	2	0	73,5	70,0	30,22		SW	1	Fine.
28	7	0	68,0	66,5	30,17		SSW	1	Fine.
	2	0	78,5	72,5	30,18		SW	1	Fine.
29	7	0	68,0	71,0	30,06		SE	1	Fine.
	2	0	84,5	74,5	30,00		SSW	1	Fine.
30	7	0	65,0	67,0	29,98		SW	1	Fair.
	2	0	74,5	71,0	30,01		NW	2	Fine.
31	7	0	56,0	59,0	30,06	0,024	NE	1	Fair.
	2	0	66 0	66,0	30,14		NE	1	Fine.

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for June 1780.

	Time. H.	Time. M.	Therm. without	Therm. within.	Barom. Inches	Rain. Inch.	Winds. Points.	Winds. Str.	Weather.
June 1	7	0	60,0	61,0	30,05		E by N	1	Fine.
	2	0	70,5	65,0	29,98		ENE	2	Fine.
2	7	0	66,5	67,0	29,93		SW	1	Fine.
	2	0	85,0	73,5	29,93		SW	1	Fine.
3	7	0	65,0	68,0	29,88		NE	1	Cloudy.
	2	0	71,0	72,0	29,95		NE	1	Fine.
4	7	0	59,0	66,0	30,07		NE	1	Fine.
	2	0	64,0	66,0	30,07		NE	1	Fair.
5	7	0	48,5	57,0	29,99	0,023	NE	1	Cloudy.
	2	0	53,5	59,0	29,99		NW	2	Cloudy.
6	7	0	49,0	55,0	29,99	0,010	NE	2	Cloudy.
	2	0	61,0	58,0	29,99		NE	2	Cloudy.
7	7	0	52,0	53,0	30,01		NE	1	Fair.
	2	0	60,0	58,0	30,02		NE	1	Fair.
8	7	0	48,0	50,0	29,99		NW	1	Fine.
	2	0	59,0	57,0	30,09		NW	1	Fine.
9	7	0	60,0	56,5	29,94		NW	1	Fine.
	2	0	62,5	60,0	29,94		NW	1	Cloudy.
10	7	0	61,0	59,0	29,80	0,018	SW	1	Fine.
	2	0	66,0	63,0	29,83		SW	1	Fair.
11	7	0	62,0	62,5	29,94		NW	1	Fine.
	2	0	70,0	65,0	29,90		W by N	1	Fine.
12	7	0	59,0	63,5	30,04		ENE	1	Cloudy.
	2	0	65,0	65,0	30,09		NE	1	Cloudy.
13	7	0	59,0	62,0	30,03		SW	1	Fine.
	2	0	72,0	69,5	29,98		SW	1	Fine.
14	7	0	55,5	61,5	29,81		SW	2	Fine.
	2	0	66,0	64,0	29,83		SW	2	Fine.
15	7	0	55,5	60,5	29,85	0,017	NW	1	Fine.
	2	0	63,0	64,0	29,92		NW	2	Cloudy.
16	7	0	56,0	59,0	30,01	0,020	WSW	1	Fair.
	2	0	63,0	62,0	30,04		SW	1	Fair.

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	Time.		Therm. without	Therm. within	Barom.	Rain.	Winds.		Weather.
	H.	M.			Inches.	Inch.	Points.	Str	
June 17	7	0	58,5	60,5	29,91	0,030	SW	1	Fair.
	2	0	67,0	63,0	29,91		SW	1	Fair.
18	7	0	56,5	58,5	29,81	0,240	SW	1	Rainy.
	2	0	65,5	64,0	29,81		SW	1	Rainy.
19	7	0	60,0	62,5	29,79	0,152	SSW	1	Cloudy.
	2	0	72,0	67,0	29,79		SW	1	Fair.
20	7	0	60,0	61,0	29,95		W by S	1	Fine.
	2	0	66,0	69,0	29,99		SW	1	Fine.
21	7	0	57,5	62,0	30,07	0,022	W by N	1	Fine.
	2	0	68,0	64,5	30,11		SW	1	Fine.
22	7	0	58,5	62,5	30,11		SSW	1	Cloudy.
	2	0	61,0	64,0	30,07		SW	1	Rainy.
23	7	0	56,0	61,0	30,04	0,320	NW	1	Fine.
	2	0	70,0	66,0	30,18		SW	1	Fine.
24	7	0	60,0	63,5	30,10		SSW	1	Fair.
	2	0	67,5	66,5	30,07		SW	1	Fair.
25	7	0	58,0	65,0	30,08		W by S	2	Fair.
	2	0	67,0	65,0	30,12		NW	2	Fine.
26	7	0	57,5	62,0	30,24		NW	2	Fine.
	2	0	66,0	65,0	30,31		SW	1	Fine.
27	7	0	56,0	62,0	30,37		NW	1	Fine.
	2	0	69,0	64,5	30,37		SW	1	Fine.
28	7	0	62,0	64,0	30,32		NW	1	Fair.
	2	0	74,0	68,0	30,28		NNW	1	Fine.
29	7	0	66,0	67,5	30,25		SE	1	Fine.
	2	0	78,0	70,0	30,19		E	1	Fine.
30	7	0	67,0	66,0	29,99		SE	1	Fine.
	2	0	84,5	76,0	29,94		ESE	1	Fine.

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	Time.		Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H.	M.			Inches.	Inch.	Points.	Str.	
July 1	7	0	64,5	70,0	29 96		SW	1	Fair.
	2	0	73,0	72,5	29 95		S by E	1	Fair.
2	7	0	63,0	68 0	29 89	0,143	SW	1	Rainy.
	2	0	73 0	72.0	29 99		SW	1	Fine.
3	7	0	61,5	68,5	29,99		SW	1	Fine.
	2	0	69,0	70,0	30,05		SW	1	Cloudy.
4	7	0	60,0	66,5	30.02		SW	1	Fair.
	2	0	70,5	68,5	30 05		NW	1	Fine.
5	7	0	61,0	67 0	30,18		SW	1	Fine.
	2	0	69,0	66 0	30 09		SW	1	Fine.
6	7	0	61,5	64,0	30 09		NW	1	Fine.
	2	0	71,0	69,0	30,08		NW	1	Fine.
7	7	0	58,5	61,0	30,06		NW	1	Fine.
	2	0	65.0	64,5	30,04		NW	1	Fine.
8	7	0	60,5	62 5	29,97		W by N	1	Fine.
	2	0	68,5	65,5	29.99		NW	1	Fine.
9	7	0	61,0	62,0	30,00		NE	1	Fair.
	2	0	68,0	66,0	30.08		WNW	1	Fine.
10	7	0	57,0	64,0	30,14	0,017	NE	1	Fine.
	2	0	67,0	66,5	30,19		NNE	1	Fine.
11	7	0	54,0	62,0	30,17		N by E	1	Fair.
	2	0	70,5	68 5	30,14		NW	1	Fine.
12	7	0	61,0	65,0	29.97		WSW	1	Cloudy.
	2	0	74,0	70,0	29,94		NNW	1	Cloudy.
13	7	0	60,0	65,5	29.98	0,116	NNW	1	Cloudy.
	2	0	68,0	68.0	30,07		NW	1	Cloudy.
14	7	0	60,0	62,5	30,16		NW	1	Fine.
	2	0	70,5	68,5	30,19		NW	1	Fine.
15	7	0	60 5	66,5	30.00		WSW	1	Cloudy.
	2	0	72,0	69,5	29,92		NW	1	Fine.
16	7	0	66,0	69,5	29,99		NW	1	Fine.
	2	0	79,5	72,0	29.98		NW	1	Fine.

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	Time.		Therm without	Therm. within	Barom.	Rain.	Winds.		Weather.
	H.	M.			Inches.	Inch.	Points.	Str.	
July 17	7	0	68,5	73,0	29,88		SE	1	Fine.
	2	0	82,0	78,5	29,87		SE	1	Fine.
18	7	0	70,0	75,0	29,74	0,028	SW	1	Fine.
	2	0	72,0	70,5	29,83		SW	1	Fair.
19	7	0	62,0	71,0	30,00		WSW	1	Fair.
	2	0	68,5	69,0	30,06		SW	1	Fine.
20	7	0	58,5	67,0	30,13		WSW	1	Fine.
	2	0	72,5	69,5	30,09		WSW	1	Fine.
21	7	0	60,0	67,0	29,87	0,038	SW	1	Rainy.
	2	0	67,5	68,5	29,76		WSW	1	Cloudy.
22	7	0	61,0	67,0	29,59	0,926	SE	1	Rainy.
	2	0	66,0	68,5	29,66		S by W	1	Rainy.
23	7	0	59,5	66,0	29,99	0,310	NE	1	Cloudy.
	2	0	66,0	67,0	30,01		NE	1	Fair.
24	7	0	58,5	65,0	30,18		SW	1	Fair.
	2	0	79,0	69,5	30,17		SW	1	Fine.
25	7	0	65,0	69,5	30,16	0,024	NNE	1	Cloudy.
	2	0	80,0	72,0	30,19		NNE	1	Fine.
26	7	0	62,5	63,5	30,24		NW	1	Cloudy.
	2	0	78,0	75,0	30,23		SW	1	Fine.
27	7	0	64,0	70,5	30,14		NW	1	Fair.
	2	0	71,0	71,0	30,21		NW	1	Fine.
28	7	0	59,0	69,0	30,34		SSW	1	Fine.
	2	0	71,5	68,5	30,34		SW	1	Fine.
29	7	0	60,0	66,0	30,25		NE	1	Fine.
	2	0	71,0	68,0	30,19		E by S	1	Fine.
30	7	0	61,5	63,0	30,11		NE	1	Cloudy.
	2	0	75,0	70,0	30,11		ESE	1	Fine.
31	7	0	60,5	66,5	30,19		ENE	1	Cloudy.
	2	0	70,5	68,5	30,19		NE	1	Fine.

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	Time. H.	M.	Therm. without	Therm. within.	Barom Inches	Rain. Inch.	Winds. Points.	Str.	Weather.
Aug. 1	7	0	59,0	65,0	30,20		NE	1	Cloudy.
	2	0	78,0	74,0	30,19		NE	1	Fine.
2	7	0	62,0	68,0	30,11		SW	1	Fair.
	2	0	78,0	71,0	30,18		SW	1	Fine.
3	7	0	61,5	68,5	30,09		NE	1	Fine.
	2	0	83,0	73,5	30,13		NE	1	Fine.
4	7	0	68,0	69,0	30,10		ENE	1	Fine.
	2	0	78,0	73,0	30,14		NE	1	Fine.
5	7	0	60,5	66,5	30,11		NNE	1	Fair.
	2	0	76,5	74,0	30,11		NW	1	Fine.
6	7	0	60,0	67,0	30,07		NNE	1	Cloudy.
	2	0	78,5	73,0	30,07		N by W	1	Fine.
7	7	0	62,0	69,0	30,12		NE	1	Fair.
	2	0	80,0	74,0	30,16		NE	1	Fine.
8	7	0	59,5	67,0	30,09		NE	1	Fair.
	2	0	77,0	75,0	30,07		NE	1	Cloudy.
9	7	0	62,5	66,0	30,02		NE	1	Fair.
	2	0	82,0	75,0	30,04		NE	1	Fine.
10	7	0	64,5	71,0	30,02		NE	1	Fine.
	2	0	81,5	76,5	30,02		E by S	1	Fine.
11	7	0	66,5	73,0	30,02		ENE	1	Fine.
	2	0	79,0	76,0	29,98		ENE	1	Fine.
12	7	0	65,0	72,0	29,91		NE	1	Fine.
	2	0	79,0	73,0	29,89		S by E	1	Fine.
13	7	0	62,5	65,0	29,89		NE	1	Fine.
	2	0	76,5	75,0	29,93		NE	1	Fine.
14	7	0	60,0	62,5	29,93		NE	1	Fair.
	2	0	62,0	69,0	29,95		NE	1	Rainy.
15	7	0	61,5	66,5	29,88	0,104	NE	1	Fair.
	2	0	68,0	69,0	29,92		NE	1	Fair.
16	7	0	65,0	68,0	29,92		NE	1	Fair.
	2	0	75,0	72,0	30,03		NE	1	Cloudy.

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	Time.	Therm. without	Therm. within.	Baroм.	Rain.	Winds.		Weather.
	H. M.			Inches.		Points.	Str.	
Aug. 17	7 0	65,5	67,5	30,02		SE	1	Fair.
	2 0	75,0	72,0	30,00		NE	1	Fair.
18	7 0	60,5	68,0	29,86	0,381	ENE	1	Rainy.
	2 0	71,0	71,0	29,85		ENE	1	Rainy.
19	7 0	64,0	66,5	29,92		NNE	1	Cloudy.
	2 0	74,0	72,5	29,99		NE	1	Fine.
20	7 0	63,5	66,0	30,12		ESE	1	Fine.
	2 0	74,5	71,5	30,13		SSE	1	Fine.
21	7 0	67,0	68,0	30,09		S by E	1	Fine.
	2 0	76,0	75,0	30,09		SE	1	Fine.
22	7 0	64,5	68,5	29,99		WSW	1	Fair.
	2 0	70,0	69,0	30,03		SW	1	Fine.
23	7 0	59,0	67,0	30,07		NW	1	Fair.
	2 0	72,0	70,0	30,14		SW	1	Fine.
24	7 0	58,5	63,0	30,18		ENE	1	Fair.
	2 0	74,0	72,5	30,19		NW	1	Fine.
25	7 0	59,5	62,0	30,13		NNE	1	Fine.
	2 0	75,0	73,0	30,15		NW	1	Fine.
26	7 0	60,5	64,0	30,16		NE	1	Fine.
	2 0	76,5	75,0	30,16		ENE	1	Fine.
27	7 0	61,0	63,0	30,15		E by N	1	Fine.
	2 0	73,5	69,5	30,08		E by N	1	Fine.
28	7 0	60,0	65,0	30,10		NE	1	Fair.
	2 0	68,5	68,0	30,11		NE	1	Fine.
29	7 0	61,0	65,5	30,19		NE	1	Fair.
	2 0	72,0	71,0	30,14		NE	1	Fine
30	7 0	61,0	67,0	30,10		NE	1	Cloudy.
	2 0	76,5	74,0	30,09		NE	1	Fine.
31	7 0	69,0	69,5	30,05		SSW	1	Fine.
	2 0	83,5	76,5	30,05		S by W	1	Fine.

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	Time. H.	M.	Therm. without	Therm. within.	Barom.	Rain.	Winds. Points	Str.	Weather.
					inches.	inch.			
Sept. 1	7	0	67,5	73.5	30,01		SSW	1	Fine.
	2	0	84,0	79,0	29,89		SW	1	Fine.
2	7	0	66,0	73,0	29,95		W by S	1	Fair.
	2	0	77,0	76,0	29,94		SW	1	Fine.
3	7	0	63,0	71,0	30,01		NE	1	Fine.
	2	0	76,0	71,0	30,05		SW	1	Fine.
4	7	0	56,0	63,5	30,01		NE	1	Fair.
	2	0	70,0	68,0	30,17		SW	1	Fair.
5	7	0	53,5	62,5	30,20		E by S	1	Fine.
	2	0	71,5	69,0	30,18		SE	1	Fine.
6	7	0	56,0	63,0	30 02		SE	1	Fine.
	2	0	71,5	69,0	29,95		SE	1	Fine.
7	7	0	57,5	62,0	29,75		ENE	1	Cloudy.
	2	0	76,0	69,0	29,73		SE	1	Cloudy.
8	7	0	65,0	68,0	29,59	0,250	SSW	1	Fair.
	2	0	72,0	70,5	29,01		SE	1	Fine.
9	7	0	58,0	67,5	29,74		S by W	1	Rainy.
	2	0	64,0	68,0	29,81		SW	1	Cloudy.
10	7	0	54,0	64,5	29,83	0 560	NNE	1	Cloudy.
	2	0	70,0	67,0	29,74		S by E	1	Rainy.
11	7	0	59 0	65,0	29,71	0,327	SSW	1	Rainy.
	2	0	67,0	67,0	29,82		SW	1	Cloudy and rain.
12	7	0	54,0	63,0	29,96	0,258	SW	1	Fine.
	2	0	67,5	66,5	29,99		NW	1	Fine.
13	7	0	61,0	62,0	30,03		S by W	1	Fine.
	2	0	69,0	65,5	29,99		SSW	1	Fair.
14	7	0	57,0	64,0	29,85	0,167	SE	1	Rainy.
	2	0	66,0	66,5	29,86		S by E	1	Cloudy.
15	7	0	57,0	63,5	29,92		S by E	1	Fine.
	2	0	62,0	73,5	29,98		SE	1	Fine.
16	7	0	62,5	65,0	29,76		SE	1	Showery.
	2	0	59,0	67,5	29,76		SE	1	Showery.

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for September 1780.

	Time.	Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H. M.			Inches.		Points.	Str.	
Sept. 17	7 0	60,5	65,0	29,49	0,225	SE	1	Rainy.
	2 0	68,0	67,0	29,49		SE	2	Fine.
18	7 0	58 0	63,5	29,49	0,572	SSW	1	Fair.
	2 0	68,0	67,0	29,58		SW	1	Fine.
19	7 0	53,0	60,0	29,64		SSE	1	Fine.
	2 0	65,0	65,0	29,68		SE	1	Fine.
20	7 0	52,5	60,5	29,67		SE	1	Fine.
	2 0	64,0	62,5	29,66		NW	1	Fine.
21	7 0	49,5	59,5	29,81		S by W	1	Fine.
	2 0	65,0	62,0	29,88		SW	1	Fine.
22	7 0	48,0	56,0	30,02		SSW	1	Fine.
	2 0	65,0	65,0	30,11		SW	1	Fine.
23	7 0	49,5	57,0	30,09		ENE	1	Fine.
	2 0	66,0	66,0	30,05		NE	1	Fine.
24	7 0	59,0	59,5	29,84		NW	1	Fair.
	2 0	66,5	65,0	29,99		NW	1	Showery.
25	7 0	54,0	58,0	30,04	0,113	SSW	1	Fine.
	2 0	66,5	67,0	30,04		WSW	1	Cloudy.
26	7 0	59,0	61,0	29,97		SW	1	Fair.
	2 0	67,0	64,0	29,92		SW	1	Fair.
27	7 0	51,0	59,0	29,90	0,079	WSW	1	Fine.
	2 0	66,0	63,5	29,94		SW	1	Fair.
28	7 0	56,0	60,0	29,75		SW	1	Cloudy.
	2 0	64,0	64,5	29,76		SW	1	Showery and cloudy.
29	7 0	53,5	61,5	29,54	0,320	SSE	1	Rainy.
	2 0	62,0	63,0	29,64		SE	1	Fair.
30	7 0	50,5	57,0	29,34	0,032	SSW	1	Rainy.
	2 0	52,0	57,0	29,14		SW	2	Rainy.

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		Time.	Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
		H. M.			Inches.	Inch.	Points.	Str.	
Oct.	1	7 0	45,0	52,5	29,19	0,076	SSW	1	Rainy.
		2 0	58,5	55,5	29,09		SSW	1	Rainy.
	2	7 0	53,0	55,0	29,07	0,106	SW	1	Fair.
		2 0	57,0	56,5	29,44		SW	2	Fine.
	3	7 0	52,5	54,0	29,57		WSW	1	Fine.
		2 0	58,5	55,5	29,64		NW	1	Fine.
	4	7 0	42,0	51,5	29,79	0,050	NNE	1	Fair.
		2 0	54,0	59,5	29,87		NW	1	Fair.
	5	7 0	41,5	50,5	30,16		NW	1	Fine.
		2 0	54,0	52,5	30,18		WSW	1	Fair.
	6	7 0	45,5	49,0	30,04		S by E	1	Cloudy.
		2 0	57,0	53,5	29,90		S by W	1	Cloudy.
	7	7 0	52,0	53,0	29,63		SSW	1	Fair.
		2 0	58,5	55,5	29,50		SW	1	Fine.
	8	7 0	43,5	52,0	29,62		SSW	1	Fair.
		2 0	57,5	54,5	29,44		SE	1	Fine.
	9	7 0	56,5	55,0	28,66	0,590	SSW	3	Rainy.
		2 0	57,0	56,5	28,82		SSW	3	Showery.
	10	7 0	51,5	50,0	28,68		SW	1	Fair.
		2 0	58,0	55,0	28,99		SW	2	Cloudy.
	11	7 0	45,5	53,5	29,51	0,020	SW	2	Fair.
		2 0	58,0	56,0	29,61		SW	2	Fair.
	12	7 0	43,5	53,0	29,68	0,025	SW	1	Fair.
		2 0	55,0	54,0	29,81		W by N	1	Fine.
	13	7 0	48,5	51,5	30,04		SSE	1	Cloudy.
		2 0	60,0	65,0	30,02		SE	2	Fair.
	14	7 0	52,0	53,5	29,75		SE	1	Cloudy.
		2 0	65,0	59,0	29,61		SE	1	Fine.
	15	7 0	58,5	59,0	29,69		SSE	1	Cloudy.
		2 0	66,0	62,0	29,69		SE	1	Cloudy.
	16	7 0	53,5	56,5	29,72	0,530	SSW	1	Rainy.
		2 0	62,0	61,0	29,71		WSW	1	Cloudy.

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	Time. H.	Time. M.	Therm. without	Therm. within.	Barom.	Rain.	Winds. Points.	Winds. Str.	Weather.	M.	E.
					Inches.	Inch.					
Oct. 17	7	0	55,0	58,0	29,87		SSW.	1	Fine.	0	8
	2	0	65,0	63,5	29,91		SSW	1	Fine.	0	8
18	7	0	49,5	55,0	30,02		NNE.	1	Cloudy.	8	
	2	0	62,0	60,0	30,07		NNE.	1	Fine.	0	8
19	7	0	53,0	59,0	29,79		SW.	2	Fine.	0	8
	2	0	56,0	59,0	29,58		SW.	2	Rainy.	8	
20	7	0	46,5	56,0	29,48	0,073	WSW.	1	Fine.	0	8
	2	0	52,0	56,0	29,44		SW.	1	Cloudy.	8	
21	7	0	47,0	50,5	29,48		NW.	2	Fine.	0	8
	2	0	55,0	53,0	29,63		WNW.	1	Fine.	0	8
22	7	0	46,0	50,5	29,73		SW.	1	Cloudy.	8	
	2	0	54,5	52,5	29,67		SW.	1	Cloudy and rainy.		
23	7	0	41,5	49,0	29,86	0,068	SW.	1	Fine.	0	8
	2	0	53,0	52,0	29,88		SW.	2	Cloudy.	8	
24	7	0	50,0	51,5	29,66		SE.	1	Cloudy.	8	8
	2	0	59,0	61,0	29,70		SE.	1	Fair.	0	8
25	7	0	43,5	51,0	29,73		NE.	1	Fine.	0	8
	2	0	51,5	52,0	29,77		NW.	1	Fine.	0	8
26	7	0	37,0	48,0	30,07		SSW.	1	Fine.	0	8
	2	0	52,0	50,0	30,14		NNE.	1	Fine.	0	8
27	7	0	43,0	46,0	30,27		NE.	1	Cloudy.	8	8
	2	0	50,0	48,0	30,29		NE.	1	Fair.	0	8
28	7	0	47,0	48,0	30,14		NNE.	1	Cloudy.	8	8
	2	0	55,0	51,5	30,07		NE.	1	Cloudy.	8	
29	7	0	47,5	51,0	29,85		NW.	1	Rainy.	8	8
	2	0	49,5	51,5	29,82		NW.	1	Rainy.	8	
30	7	0	49,5	51,5	29,71	0,435	NNW.	1	Rainy.	8	8
	2	0	50,0	52,0	29,82		NNW.	1	Rainy.	8	
31	7	0	49,5	52,0	29,88	0,373	SW.	1	Rainy.	8	8
	2	0	50,5	52,5	29,89		NE.	1	Rainy.	8	

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	Time.	Therm. without	Therm. within.	Barom.	Rain.	Winds.		Weather.
	H. M.			Inches.	inch.	Points.	Str.	
Nov. 1	8 0	47,5	49,5	29,94	0,118	NNE	1	Cloudy.
	2 0	50,0	51,0	30,02		NE	2	Rainy.
2	8 0	46,0	48,5	30,08		NNE	1	Cloudy.
	2 0	50,0	51,0	30,08		NE	1	Fine.
3	8 0	46,0	48,5	29,97		NE	1	Cloudy.
	2 0	50,0	53 0	29,94		NE	1	Fair.
4	8 0	40,0	46,0	29 97		NW	1	Fine.
	2 0	46,0	47,0	30,08		NW	2	Fine.
5	8 0	47,0	47 0	29,83	0,039	SW	1	Fine.
	2 0	51,5	49,0	29,72		NW	2	Fine.
6	8 0	40,0	45,0	29 86		NW	2	Fine.
	2 0	44,0	45,0	29,87		NW	2	Fine.
7	8 0	35,0	37,5	29 72	0,039	NNE	2	Fine.
	2 0	36,0	38 0	29,82		NE	3	Snowy.
8	8 0	36,0	37,5	29,91	0,081	NNE	2	Fine.
	2 0	42,0	40,0	29 94		NE	1	Fine.
9	8 0	33,0	37,5	30 09		SW	1	Cloudy.
	2 0	41,0	40,0	30,05		SSW	1	Cloudy.
10	8 0	48,5	44,0	30 07	0,075	NE	1	Cloudy.
	2 0	52,0	47,0	30,11		NE	1	Fair.
11	8 0	46,5	45 0	30,11		NE	1	Cloudy.
	2 0	52,0	48,0	30 17		NNE	1	Cloudy.
12	8 0	47,0	49,0	30,09		WSW	1	Fine.
	2 0	51,0	49,5	30.12		WSW	1	Cloudy.
13	8 0	51,5	50,0	29 73		SW	3	Cloudy.
	2 0	52,0	51,0	29,64		SW	3	Cloudy.
14	8 0	39,5	47,0	29 82		WSW	1	Fair.
	2 0	47,0	47 5	29,84		WSW	1	Fine.
15	8 0	30,0	41,0	29 97	0,095	NW	1	Fine.
	2 0	36 0	41 0	30,02		NW	1	Fine.
16	8 0	26,0	36 0	29,93		SE	1	Foggy.
	2 0	28,5	38,0	30 16		SE	1	Foggy.

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	Time. H.	Time. M.	Therm. without	Therm within.	Barom. Inches.	Rain. Inch	Winds. Points.	Winds. Str.	Weather.
Nov. 17	8	0	36,5	38,5	29,73		SE.	1	Foggy.
	2	0	40,0	41,0	29,63		SE	1	Rainy.
18	8	0	41,0	40,0	29,60	0,030	SE	1	Cloudy.
	2	0	45,0	42,0	29,53		SSE	1	Fair.
19	8	0	41,0	42,5	29,27	0,039	NW	1	Fair.
	2	0	43,5	44,0	29,32		NW	1	Fine.
20	8	0	43,0	43,5	28,94	0,616	W by S	1	Cloudy.
	2	0	46,0	49,0	29,02		SW	1	Fair.
21	8	0	36,5	41,5	29,14	1,074	NW	1	Fair.
	2	0	41,5	43,0	29,31		NW	1	Cloudy.
22	8	0	36,0	41,0	29,14	0,025	SW	1	Cloudy.
	2	0	37,0	40,5	29,08		WNW	1	Fine.
23	8	0	31,0	37,0	29,39		NW	1	Fine.
	2	0	37,0	38,0	29,42		NW	1	Fair.
24	8	0	31,0	39,0	29,64		SW	1	Foggy.
	2	0	36,0	38,0	29,50		SW	1	Rainy.
25	8	0	36,0	39,0	29,89	0,236	NW	1	Cloudy.
	2	0	38,0	40,5	29,98		WSW	1	Cloudy.
26	8	0	42,0	39,5	30,10		WSW	1	Cloudy.
	2	0	48,0	42,0	30,14		NW	1	Cloudy.
27	8	0	44,0	45,0	30,27	0,038	NW	1	Cloudy.
	2	0	47,0	45,0	30,28		NNW	1	Cloudy.
28	8	0	42,0	44,5	30,46		ENE	1	Cloudy.
	2	0	45,5	46,0	30,47		NE	1	Fine.
29	8	0	37,0	42,0	30,45		NNE	1	Fine.
	2	0	46,0	43,0	30,40		NNE	1	Fine.
30	8	0	37,5	42,5	30,32		NNE	1	Fine.
	2	0	40,5	42,0	30,32		NNE	1	Fine.

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		Time.	Therm. without	Therm. within	Barom.	Rain.	Winds.		Weather.
		H.	M.			Inches.	Inches.	Points.	Str.	
Dec.	1	8	0	38,5	40,5	30,13		NE	1	Fair.
		2	0	43,5	41,5	30,31		NE	1	Fair.
	2	8	0	42,0	42,5	30,34		NE	1	Cloudy.
		2	0	44,0	46,0	30,36		NE	1	Cloudy.
	3	8	0	38,0	40,0	30,47		NE	2	Cloudy.
		2	0	41,5	43,0	30,49		NE	2	Cloudy.
	4	8	0	40,5	41,5	30,51		NE	1	Fine.
		2	0	45,0	44,0	30,49		NE	1	Cloudy.
	5	8	0	39,5	42,0	30,45		NE	2	Cloudy.
		2	0	43,5	44,0	30,40		NE	1	Cloudy.
	6	8	0	38,0	41,5	30,35		NE	1	Cloudy.
		2	0	39,0	42,5	30,33		NE	1	Cloudy.
	7	8	0	33,0	39,5	30,29		NE	1	Cloudy.
		2	0	33,5	36,0	30,28		NE	1	Cloudy.
	8	8	0	36,0	39,0	30,29		NE	1	Fine.
		2	0	40,0	40,0	30,31		NE	1	Fair.
	9	8	0	45,0	48,0	30,53		NE	1	Fair.
		2	0	40,0	40,0	30,53		NE	1	Fair.
	10	8	0	33,5	37,0	30,45		WSW	1	Fair.
		2	0	38,0	36,0	30,44		SW	1	Cloudy.
	11	8	0	38,5	40,0	30,38		NW	1	Fine.
		2	0	45,0	42,0	30,34		NW	1	Fair.
	12	8	0	41,0	41,5	30,45		SW	1	Foggy.
		2	0	45,5	43,0	30,41		S by E	1	Foggy.
	13	8	0	40,5	43,5	30,44		NW	1	Foggy.
		2	0	44,0	44,0	30,39		WNW	1	Cloudy.
	14	8	0	40,0	42,0	30,36		SW	1	Foggy.
		2	0	45,0	45,0	30,46		SW	1	Fair.
	15	8	0	41,0	44,0	30,44		NW	1	Fine.
		2	0	45,0	45,0	30,46		NW	1	Fair.
	16	8	0	40,0	44,5	30,55		NNE	1	Foggy.
		2	0	43,5	45,0	30,55		SE	1	Cloudy.

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	Time. H.	M.	Therm. without	Therm. within.	Barom. Inches.	Rain. Inch.	Winds. Points.	Str.	Weather.
Dec. 17	8	0	40,0	44,0	30,51		SW	1	Foggy.
	2	0	43,5	44,0	30,48		NW	1	Fine.
18	8	0	34,5	41,0	30,46		NE	1	Foggy.
	2	0	40,0	41,5	30,46		ENE	1	Fine.
19	8	0	30,5	38,0	30,49		ENE	1	Fine.
	2	0	34,5	36,0	30,40		NE	1	Fine.
20	8	0	30,0	34,5	30,08		NE	1	Foggy.
	2	0	32,0	39,0	29,99		NE	1	Foggy.
21	8	0	28,0	33,0	29,69		S by E	1	Foggy.
	2	0	29,0	34,5	29,69		S by E	1	Foggy.
22	8	0	33,0	34,0	29,85		WSW	1	Foggy.
	2	0	30,5	35,0	29,89		NW	1	Fine.
23	8	0	24,0	32,0	30,05		SSW	1	Foggy.
	2	0	32,5	34,0	30,06		NW	1	Fine.
24	8	0	34,0	34,5	30,15		NNE	1	Foggy.
	2	0	37,0	35,5	30,15		N by E	1	Fair.
25	8	0	37,0	37,5	30,21		NNE	1	Fair.
	2	0	38,5	37,5	30,23		NNE	1	Fair.
26	8	0	32,5	34,5	30,26		ENE	1	Fair.
	2	0	36,0	36,5	30,26		N by E	1	Fair.
27	8	0	29,5	32,5	30,26		NE	1	Frosty.
	2	0	32,0	34,5	30,29		NE	1	Frosty.
28	8	0	32,5	33,5	30,35	0,100	SSW	1	Foggy.
	2	0	37,0	36,5	30,34		SW	1	Cloudy.
29	8	0	40,5	37,0	30,13	0,210	SW	1	Cloudy.
	2	0	45,0	39,0	30,03		WSW	1	Fair.
30	8	0	45,0	41,0	30,01		WSW	1	Cloudy.
	2	0	50,0	44,0	30,07		SW	1	Cloudy.
31	8	0	43,5	44,0	30,06		SSW	1	Cloudy.
	2	0	50,0	46,5	30,07		WSW	1	Fair.

1780	Thermometer without.			Thermometer within.			Barometer.			Rain.
	Greateſt Height.	Leaſt Height.	Mean Height.	Greateſt Height.	Leaſt Height.	Mean Height.	Greateſt Height.	Leaſt Height.	Mean Height.	Inches.
Jan.	47,0	20,0	31,9	40,5	24,5	33,6	30,35	28 59	29,77	0,692
Feb.	53,5	20,0	37,8	49,0	31,0	38,4	30,52	29,08	29,91	0,858
Mar.	59,0	34,5	51,4	56,5	36,0	49,9	30,45	29,38	29,91	1,189
Apr.	65,5	33,0	46,7	65,0	38,0	48,0	30,17	28,81	29,65	2,739
May	84,5	45.0	59,7	74,5	51,0	60,4	30,28	29,38	29,94	0,822
June	84,5	48.0	62,9	76,0	50,0	63.2	30,37	29,79	30,01	0,852
July	82,0	54,0	66,4	78,5	61,0	69,4	30,34	29,59	30,05	1,602
Aug.	83,5	58,5	69,2	76,5	62,0	68,3	30,20	29,85	30,05	0,485
Sept	84,0	48,0	61,3	79,0	56,0	65,2	30,20	29,14	29,83	2,903
Oct.	66,0	41,5	52,3	65,0	46,0	52,9	30,29	28,66	29,69	2,356
Nov.	52,0	26,0	42,0	53,0	36,0	43,6	30,47	28,94	29,85	2,505
Dec.	50,0	24,0	38,5	46,5	32,0	39,8	30,55	29,69	30,29	0,310
Whole year			51,7			52,8			29,91	17,313

VARIA-

VARIATION NEEDLE.

	7 h. A. M.	12 h. M.	2 h. P.M.	10 or 11h. P.M.	Daily Means.
	° ′	° ′	° ′	° ′	° ′
June 5	22 25	22 26	22 21	22 23	22 24
6	22 21	22 29	22 57	22 44	22 38
7	22 30	22 49	22 48	22 29	22 39
8	22 45	22 44	22 45	22 46	22 45
9	22 31	22 42	22 48	22 40	22 40
10	22 25	22 48	22 57	22 40	22 42
11	22 45	22 49	22 48	22 44	22 46
12	22 37	22 49	22 46	22 41	22 43
13	22 31	22 53	22 45	22 35	22 41
14	22 29	22 55	22 50	22 50	22 46
15	22 25	22 40	22 49	22 47	22 40
16	22 45	22 48	22 47	22 49	22 47
17	22 27	22 [illegible]	22 55	22 55	22 43
18	22 39	22 37	22 41	22 48	22 41
Means	22 32	22 43	22 47	22 42	
Mean of all 22° 41′.					

DIPPING NEEDLE.

	7 h. A.M.	12 h. M.	2 h P.M.	10 or 11h. P.M.	Means.	
	° ′	° ′	° ′	° ′	° ′	
June 5	72 0	72 5	72 0	72 0		
6	72 5	72 5	72 10	72 10	72 3	Weſt mark down.
7	72 0	72 0	72 10	72 0		
8	72 0	72 0	72 5	72 10		
9	72 20	72 20	72 20	72 20	72 21	Eaſt.
10	72 20	72 20	72 30	72 10		
11	72 20	72 30	72 25	72 10		
12	72 30	72 30	72 30	72 0		
13	72 5	72 15	72 10	72 10	72 13	Eaſt mark uppermoſt.
14	72 10	72 15	72 20	72 10		
15	72 20	72 15	72 20	72 20		
16	72 45	72 40	72 40	72 20		
17	72 40	72 30	72 25	72 30	72 32	Weſt.
18	72 40	72 20	72 30	72 20		

THE END OF PART I. OF VOL. LXXI.

ERRATA.

Page 9. Over the table add, Grs.

The last line of the table read 0,035.

22. col. 1. l. 18. read 18,445.

30. the whole of col. 7. and 8. should be removed one line lower.

TRATA

Explanation of the plates to Mr. SMEATHMAN's Account of the Termites of Africa, &c.

TAB. VII. fig. 1. The hill-neſt raiſed by the Termites bellicoſi, deſcribed page 148.

aaa. Turrets by which their hills are raiſed and enlarged, p. 150.

Fig. 2. A ſection of fig. 1. as it would appear on being cut down through the middle from the top a foot lower than the ſurface of the ground, p. 154.

AA. An horizontal line from A on the left, and a perpendicular line from A at the bottom, will interſect each other at the royal chamber, p. 154.

The darker ſhades near it are the empty apartments and paſſages, which it ſeems are left ſo for the attendants on the king and queen, who, when old, may require near one hundred thouſand to wait on them every day.

The parts which are the leaſt ſhaded and dotted are the nurſeries, ſurrounded, like the royal chamber, by empty paſſages on all ſides for the more eaſy acceſs to them with the eggs from the queen, the proviſion for the young, &c. N. B. The magazines of proviſions are ſituated without any ſeeming order among the vacant paſſages which ſurround the nurſeries.

B. The top of the interior building, which often ſeems, from the arches carrying upward, to be adorned on the ſides with pinnacles, p. 156.

C. The floor of the area or nave, p. 156.

DDD. The large galleries which aſcend from under all the buildings ſpirally to the top, p. 156.

EE. The bridges, p. 158.

Fig. 3. The firſt appearance of an hill-neſt by two turrets, p. 150.

Fig. 4. A tree, with the neſt of the Termites arborum, and their covered way, p. 161.

FFFF. Covered ways of the Termites arborum, p. 173.

Fig. 5. A ſection of the neſt of the Termites arborum.

Fig. 6. A neſt of the Termites bellicoſi, with Europeans on it, ſeemingly obſerving a veſſel at ſea, p. 151.

Fig. 7. A bull ſtanding centinel upon one of theſe neſts, while the reſt of the herd is ruminating below, p. 151.

GGG. The African palm-trees, from the nuts of which is made the Oleum Palmæ.

Tab. VIII. fig. 1. A tranſverſe ſection of a royal chamber, p. 151.

aa. The thin ſides in which the entrances are made, p. 152.

Fig. 2. A longitudinal ſection of a royal chamber, p. 151.

b. The entrances, p. 187.

A. The door ſhut up, as left by the labourers, p. 187.

Fig. 3. A royal chamber fore-ſhortened.

Fig. 4. The ſame royal chamber repreſented as juſt opened, and diſcovering (B) the queen, and her attendants running round her. p. 188.

bb. A line drawn from *b* to *b* will run along the range of doors or entrances, p. 187.

AAA. A line run from A to AA will croſs the door, which remains cloſed as it was found. The reſt are repreſented as they appear ſince the mortar, with

with which they were ſtopped up, has been in part or wholly picked out with a ſmall inſtrument, p. 187.

Fig. 5. A nurſery, p. 153.

Fig. 6. A little nurſery, with the eggs, the young ones, the muſhrooms, mouldineſs, &c. as juſt taken from the hill, p. 153.

Fig. 7. The muſhrooms magnified by a ſtrong lens, p. 154.

Tab. IX. fig. 1. and 2. The turret neſts, with roofs of the Termes mordax and a Termes atrox as finiſhed, p. 159.

Fig. 3. A turret, with the roof begun.

Fig. 4. A turret, raiſed only about half its height.

Fig. 5. A turret, building upon one which had been thrown down, p. 160.

Fig. 6. 6. A turret, broken in two.

Tab. X. fig. 1. A Termes bellicoſus, p. 141. numb. 1. and p. 165.

Fig. 2. A KING. N. B. A king never alters his form after he loſes his wings, neither does he apparently increaſe in bulk.

Fig. 3. A QUEEN, p. 170.

Fig. 4. The head of a perfect inſect magnified.

Fig. 5. A face, with ſtemmata magnified, p. 141. numb. 1.

Fig. 6. A labourer, p. 163.

Fig. 7. A labourer magnified.

Fig. 8. A ſoldier, p. 164.

Fig. 9. A ſoldier's forceps and part of his head magnified, p. 164.

Fig. 10. The Termes mordax, p. 141. numb. 2. and p. 161.

Fig. 11. The face with the ſtemmata magnified, p. 141. numb. 2.

Fig. 12. A labourer.

Fig. 13. A ſoldier.

Fig. 14. The Termes atrox, p. 141. numb. 3. and p. 160.

Fig. 15. The face and ſtemmata magnified, p. 141. numb. 3.

Fig. 16. A labourer.

Fig. 17. A ſoldier.

Fig. 18. Idem.

Fig. 19. The Termes deſtructor, p. 141. numb. 4.

Fig. 20. The face and ſtemmata magnified, p. 141. numb. 4.

Fig. 21. The Termes arborum, p. 141. numb. 5. and p. 162.

Fig. 22. The face and ſtemmata magnified, p. 141. numb. 5.

Fig. 23. A labourer.

Fig. 24. A ſoldier.

Fig. 25. A QUEEN, p. 172.

N. B. In the figures 5. 11. 15. 20. and 21. the two white ſpots between the edges are the ſtemmata.